1988

The Relationship Between Selected Social and Environmental Factors and Cancer Mortality by Planning District in South Dakota, 1960-1980

Mansour Haghighatian

THE RELATIONSHIP BETWEEN SELECTED SOCIAL AND ENVIRONMENTAL FACTORS AND CANCER MORTALITY BY PLANNING DISTRICT IN SOUTH DAKOTA 1960 - 1980

BY

MANSOUR HAGHIGHATIAN

A dissertation submitted in partial
fulfillment of the requirements for the degree
Doctor of Philosophy
Major in Sociology
South Dakota State University
1988

THE RELATIONSHIP BETWEEN SELECTED SOCIAL AND ENVIRONMENTAL FACTORS ON CANCER MORTALITY BY PLANNING DISTRICT IN SOUTH DAKOTA 1960 - 1980

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Doctor of Philosophy, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Dr. Linda Baer
Thesis Advisor Date

Dr. James Satterlee
Sociology Department, Chair Date

THE RELATIONSHIP BETWEEN SELECTED SOCIAL AND ENVIRONMENTAL FACTORS AND CANCER MORTALITY BY PLANNING DISTRICT IN SOUTH DAKOTA 1960 - 1980

Abstract

Mansour Haghighatian

This paper investigated the association between selected social and environmental factors and age and sex-specific cancer mortality by planning district in South Dakota for 1960 to 1980.

Social factors included median family income, percent of families in poverty, education, and urbanization. Environmental factors included herbicide use, pesticide use, and fertilizer use. Selected demographic variables, such as age, sex, and race were uses as control variables.

Modernization theory was chosen as the conceptual framework. It was asserted that as the United States industrialized, standard of living also rose, and a shift from communicable diseases to degenerative illnesses as major causes of death also took place, thus making cancer an important factor in mortality analysis.

Census, vital statistics data, and agricultural census data were utilized. For statistical purposes, multiple regression analysis (Leaps and Bounds procedure) was performed to identify the variables or sets of

variables and their explanations of the variability in the dependent variable. Correlation was also performed to test research hypotheses.

It was found that death due to female breast cancer had the highest increase in South Dakota from 1960 to 1980, followed by respiratory organs death and lymphatic tissues cancer death. However, death due to connective tissues and genital organs cancer had decreased during this period.

Of the independent variables considered, income, herbicide use, percent of poverty families, and education were significantly related to different types of cancers.

ACKNOWLEGEMENTS

I would like to express my appreciation to the many people whose expertise, guidance, and support helped make this study and my education possible.

The consultation and guidance of Dr. Linda Baer, my dissertation advisor, was invaluable. Her prompt return of read materials and pleasant attitude reduced the frustrations associated with writing a dissertation.

I would also like to thank Dr. James Satterlee, Head of the Department of Rural Sociology, for his support and encouragement, and Dr. Lee Tucker for his statistical and computer assistance. Thanks also to my committee members Drs. Robert Mendelsohn, Diane Kayongo-Male, Nels Granholm, and Howard Smith, for their guidance.

Last but not least, thanks are due to my friend Donald Arwood, for his assistance with census and vital statistics data.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

STATEMENT OF THE PROBLEM AND STUDY OBJECTIVES

Introduction

The United States mortality rate has, in general, steadily declined since the mid-nineteenth century. The "mortality rate for the white population was 21.4 per 1000 in 1855, it dropped to 17.2 per 1000 population by 1900, and by 1981, the death rate was 8.7 per 1000 population" (PRB, 37,2:15).

The decline was basically a consequence of modernization which improved both living conditions and medical care. Modernization, as a process of economic development and social change, has impacted other spheres of society as well. It introduced industrial production to pre-industrial society, thereby dramatically increasing productivity. It also brought about many changes in health technology, the application of which decreased the number and rate of premature deaths among the members of all age groups and it added many years to life expectancy. This in turn led to the control of infectious and communicable diseases such as cholera, tuberculosis, and the like.

However, modernization also had the effect of speeding up the pace of life; pressuring people to be constant and efficient with their time, increased

mobility, thereby "weakening" traditional family ties, producing and exposing humans to many different kinds of chemicals. For instance, as far as agricultural chemicals are concerned, "An estimated 1.4 billion pounds of pesticides are applied in the United States,... a one-thousand percent increase since 1947" (Fox, 1986:140).

These factors of modernization helped people survive childhood and communicable diseases and increased life expectancy, thereby making degenerative diseases like heart diseases, cancer, hypertension, and the like, leading causes of death. In fact, "heart disease has remained the leading cause of death for the last 40 years" (PRB, 37,2:17). In this process, long term changes in population also took place. That is, as the society moved from pre-industrial to industrial, both birth rates and death rates declined, although at different paces and times.

Death rates in South Dakota

Death rates in South Dakota have generally followed the pattern of the United States. That is, degenerative diseases have replaced infectious ones as major causes of death. Whereas in 1910, heart diseases were responsible to 8.2 percent and cancer for 6.6 percent of South

Dakota's deaths, they were responsible for 14.6 percent and 8.6 percent, respectively, in 1930. In 1980, deaths due to heart diseases counted for 40.9 percent of all deaths and the number for cancer had increased to 19.3 (South Dakota Department of Health, 1910, 1932, 1982). Interestingly enough, a difference between South Dakota and the United States mortality rates is that South Dakota's rate has slightly increased during the past few decades. South Dakota's death rate in 1900 was 7.1 per 1000 population, it increased to 9.7 in 1960, and in 1981, it was 9.3 per 1000 population (South Dakota Department of Health, 1910, 1961, 1982). This is, however, basically due to an increase in the proportion of older people in South Dakota. That is, whereas in 1890, only 4.4 percent of South Dakota population was 60 years of age and over, this number had increased to 17.7 percent by 1980, as compared to 15.7 percent for the United States population in general in 1980 (Riley et al., 1984:7,13).

Statement of the Problem

This research investigates the association between selected social and environmental factors and age and sex-specific cancer mortality by region (planning district) in South Dakota for 1960 through 1980.

Social factors include median income, percent of families in poverty, urbanization, and education. Environmental factors include use of agricultural chemicals, (like pesticides and herbicides, in terms of percent of regional farmland treated with each chemical), that have been shown to be carcinogenic. Selected variables like sex, age, and race, will be treated as control variables.

Importance of the Problem

Cancer is as much a sociological phenonmonon as it is biological. That is, many of the factors that are significantly related to cancer, like education or occupation, are sociological in nature. Cancer is the second leading cause of death in the United States. Each year over 800,000 Americans are diagnosed as having cancer and over 400,000 will die from it (Roth, 1985:vii) and although some assert that cancer is "inevitable" (Fox, 1982:108), others argue that according to National Cancer Institute research, "It has been estimated that as much as 90 percent of all human cancers are caused by environmental factors ranging from pesticides to industrial chemicals" (Fox, 1986:67), and therefore could be avoided (or postponed) through better understanding of the associated variables (Goode and Rosenbaum, 1983:75).

Farm chemicals have been implicated as possible causes of certain cancers. This is an important issue considering the dependency of South Dakota on agriculture. According to Schluter and Edmonds (1986:33), if the proportion of farmworkers to the state's total food and fiber system jobs (all agricultural related jobs such as farm production, farm chemical production, assembling, processing and distributing raw farm products) is considered as the criterion for agricultural dependency, then South Dakota ranked number one.

At the closing of his article on "cancer mortality in Iowa Farmers, 1971-78", Burmeister (1981:464) suggests that, "Research to assess the possible roles of fertilizers, insecticides, fungicides, and herbicides in causing cancers should continue". Buesching and Wollstadt (1984:503) observed that, "A study recently conducted in Iowa and reported in this journal is the only one to focus exclusively on farmers in the midwest". It is hoped that this study, which focused on an agricultural midwestern state, will shed more light on the relationship between environmental factors and cancer mortality.

Objectives of the Study

The objectives of this study are as follows:

1) To describe patterns that have occurred in

cancer- specific death rates by age, sex, and race over time. That is, to see if members of any of these groups are more prone to specific types of cancer.

2) To investigate if there is an association between social and environmental factors and cancer deaths rates.

Organization of the Dissertation

The remainder of the dissertation is organized as follows:

1. Chapter II reviews the selected literature pertinent to the subject.

2. Chapter III includes the theoretical orientation utilized in the study.

3. Chapter IV contains the research design and methodology. It also contains operational definitions of the variables and research hypotheses.

4. Chapter V presents the findings of the study and presents interpretations about the findings.

5. Chapter VI contains the summary, conclusions, and implications of the study. Suggestions for future research are also included in this chapter.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

Although cancer has been around for quite some time, it was not until the early decades of this century that it rose to become one of the leading causes of death in the United States. Whereas in 1900 cancer ranked ninth among the ten leading causes of death and was responsible to 3.7 percent of all deaths, in 1930 it ranked third and was responsible for 8.6 percent of deaths (Omran, 1980:27). By 1940, cancer was the second leading cause of death and has remained so ever since (PRB, 37, 2:17). This chapter includes a review of studies and literature which can provide better understanding of cancer and its determinants, primarily the social influences. However, before we proceed, a few points should be clarified.

When implicating cancer as a cause of death, care is taken to note that the increased noticeability of cancer does not necessarily mean an actual increase in cancer incidence. This is because:

a) Whereas previously such matters [like cancer] often used to be hushed up and the diagnosis was perhaps withheld even from the victim, nowadays people may discuss it with friends and relatives.

b) Cancers are now diagnosed that might previously

have gone unnoticed in the medical treatment (and subsequent death certification) of dying people.

c) Cancer has become more common as a cause of death chiefly because of the prevention or cure of so many other diseases.

d) There is a larger proportion of old people today, and cancer risks are greater in old people (Doll and Peto, 1981:1207; also Lilienfeld, 1972:8-10).

FACTORS AFFECTING CANCER RATES

The Problem of Causality

A major problem in dealing with cancer is causality. The most important issue in this category is due to the fact that most cancers have a latency period between one to three decades (Doll and Peto, 1981:1239; also Roth, 1985:39). That is, cancer in humans develops many years after the initial exposure to a carcinogen and it is hard to keep other variables in check during this long period.

Another problem is that many substances are not directly effective as carcinogens. However, these substances are or can be metabolically altered to become carcinogenic (Griffiths, 1984:8). In addition, some chemicals become more carcinogenic in association with other factors. For example, "Dust and high levels of ozone...increase production of paroxon from the widely

used organophosphate pesticide parathion 30-fold over cleaner settings"..."Paroxon, formed by the addition of oxygen to parathion, is 10 to 100 times more toxic than parathion and appears to have caused at least 29 poisonings in California field-workers " (Fox, 1986:73).

A third problem is the different reaction of different people to the same cause. For example, "in the case of asbestos, it may cause disease in some people but not in others working right alongside them under virtually identical circumstances" (Polakoff and Rosenbaum, 1983:202).

In considering the causes of cancer, it is important to note that there are a multitude of factors in complex interplay that lead to the onset of cancer. In delineating determinants of who will and who will not develop cancer, according to Doll and Peto (1981:1203), one should pay attention to three categories; "not only 'nature', 'nurture', but also 'luck' or the play of chance". "Nature" refers to an individual's genetic make up, and this certainly influences the likelihood of developing some types of cancers. "Nurture" refers to social and environmental factors influencing one's risks of getting cancer (More will be said about the nature and nurture factors later). But these two categories do not constitute all the determinants. "Luck takes care of the

remaining differences in outcome" (Doll and Peto, 1981: 1204). The argument is that in studies done on animals, even among genetically identical animals kept under closely uniform laboratory conditions, some will die of cancer in middle age, while others might live on into old age without cancer. Or, for example, some people die of cancer at the age of 40 or 50 while some others living under similar circumstances will go on living into their 70s and 80s. Therefore, it is suggested that "Nature and nurture affect the probability that each individual will develop cancer, and luck then determines exactly which individuals will actually do so" (Ibid.). It should be noted that even though the role of chance or luck might be enormous on an individual basis, on an aggregate basis its influence is minimal, since good and bad luck can average each other out. Therefore, as far as this study is concerned, chance is given no role to play. Now, with these points in mind, an examination of some of the factors that have been suggested by the literature as causing cancer or increasing one's susceptibility to cancer will be discussed.

Susceptibility

Carcinogens do not affect everyone who is exposed to them identically, and it appears that some people are

more prone to getting cancer than others. The following are some suggested factors influencing this differential susceptibility. Since these factors do not cause cancer by themselves, in this study , they will be considered as control variables.

Genetic and Biological Factors

It has been suggested that individuals with certain genetic characteristics are more susceptible to some cancers. For example, it has been shown that in the development of leukemia in identical twins, "the risk is 1 in 5 of developing leukemia within a few months of the onset of the disease in the other twin if one twin has the disease" (Griffiths, 1984:4). Or that people "whose 'ABO' blood group (a factor that is determined purely genetically) is of type 'A' have a stomach cancer risk some 20% greater than that of their compatriots of type 'O' (Doll and Peto; 1981:1204). Of the genetic and biological factors, age, sex, and race are discussed below.

Age

Cancer has sometimes been called the disease of old age (Roth, 1985:1). In fact, about 50 percent of all cancers occur in those who are over 64 years of age

(Griffiths, 1984:379). The following are among possible explanations of the age factor:

a) Advancing age allows for prolonged exposure to occupational and environmental materials that could be carcinogenic.

b) With advanced age comes the breakdown (or weakening) of the body's immuno-surveillance system, making the aged more vulnerable.

c) Intrinsic cellular factors and changes in hormonal levels of the aging individuals renders them more susceptible (Griffiths, 1984; also Kent, 1977).

It should also be noted that with aging comes a general deterioration of the body and it's different organs, like decreasing elasticity of the lungs, decreased cardiac output, diminished muscle size and strength, and the resulting fatigue. All these make the aged susceptible to more diseases including cancer. However, some doubt whether thinking of aging per se as an important determinant of cancer is scientifically fruitful, since it can not be interferred with (Doll and Peto, 1981:1205).

Sex

Men and women seem to be differentially susceptible

to different types of cancers. For instance, cancer of the breast is more prevalent among women, whereas cancer of the digestive tract is more frequent among men.

The fact that men and women have differential morbidity and mortality has been a subject of curiosity and research. To be sure, the mortality differential between the sexes has increased since the early decades of this century; "male and female expectations of life at birth in the United States increased from 48.46 and 52.01 years in 1910- a 3.55 year difference- to 66.88 and 73.87 years in 1965- a 6.99 difference- an increase of 3.43 years in the sex mortality differential" (Retherford, 1975:25).

Some might argue that this difference is biological. That is, males have inferior longevity compared to women. In fact, Retherford (1975:9) reports that Hamilton (1948) "reviewed approximately sixty studies encompassing about seventy-five species and found inferior male longevity in almost every case. Represented were nematodes, crustaceans, insects, arachnids, reptiles, birds, and fish, as well as mammals". Furthermore, in a study of the Catholic brotherhoods and sisterhoods who have similar and constant life-styles, it was found that mortality differences between the sexes were similar to that of the general population (Madigan, 1956).

On the other hand, research also shows that in countries where female status is low, female mortality could be higher than that of the male's. Bogue (1969:569) asserts that:

> Until very recently in India death rates for females appeared to be higher than for males at almost all ages. This has been thought to be associated with the neglect of females when they become ill and the concentration of medical care on male members of the family.

Sex mortality differentials can also be substantially affected by social factors. In analyzing data on the effects of cigarette smoking on sex mortality differentials, Retherford (1975:104) observes that:

> Analysis shows that smoking accounted for about 47 percent of the female-male difference in 50e37 (life expectancy between 37 and 87, the age range of the ACS [American Cancer Society] data) in 1962, and about 75 percent of the increase in the female-male difference in 50e37 between 1910 and 1962.

In a study concerned with the relationship between malignant lymphoma and multiple myeloma and agricultural chemicals in New Zealand, Pearce et al. (1985:233), found that among other things, men were at a higher risk of non-Hodgkin's lymphoma and multiple myeloma; "the observation that males' rates are consistently higher than those in females could suggest a possible occupational risk factor".

Therefore, both social and biological factors, seem to be at work in creating the sex mortality differential. Three general hypotheses have been suggested to explain the sex mortality differential:

1) The high male/female ratio reflects the fact that males are exposed to environmental carcinogens.

2) Males are, by their very nature, more susceptible, with exposure to carcinogens remaining the same for both sexes.

3) Both increased exposure and increased predisposition are involved in high male/female ratio (Lilienfeld et al., 1972:108).

Race

In ethnically complex societies, where more than one racial group lives, morbidity and mortality levels could (and usually do) differ. That is indeed the case in the United States. Weeks (1986:156) reports that data gathered by Kitagawa and Hauser for the United States for 1960 shows that "at every age up to 75, nonwhite mortality is higher than white mortality by more than 10 percent". More specifically, "Between ages 30 and 40, nonwhite death rates are more than double those for whites" (Ibid.).

Thus, the issue of racial mortality differentials,

like the issue of sex differentials, is a complex one. That is, there is an interplay between biological and social factors. For instance, "other things being equal, a white-skinned person is more likely to develop skin cancer in response to sunlight than is a black-skinned person" (Doll and Peto, 1981:1203). Or in a study by Agu at al. (1980) on the relationship between racial and occupational factors and multiple myeloma in Texas, they found that of those employed in certain occupations, blacks had higher risks of multiple myeloma. When they controlled for percentage black, they noticed that while the mortality rate for some occupations decreased, it actually increased for some other occupations, "which thus emphasizes the possible importance of race as a confounding variable in an ecologic analysis of environmental and industrial exposures associated with mortality due to multiple myeloma" (Agu et al., 1980:738).

On the other hand, in multiracial societies, one racial group usually tends to dominate others. This generally leads to social and economic disadvantages for the subordinate groups, in the forms of less educational chances, lower economic status, and therefore lower access to health and medical care, which in turn would affect morbidity and mortality of the subordinate groups.

In these situations then, mortality differentials among races might actually be due to social factors, not racial. A study by Devesa and Diamond (1980) investigated the relationship of breast and cervical cancers with income and education among blacks and whites. With reference to breast cancer, they found that:

> the 30% higher rate among white women seen in the total TNCS [Third National Cancer Survey] is reduced to a 20% excess in the socioeconomically truncated population used in this analysis. The racial difference in breast cancer risk is further reduced by adjustment for either income or education (Devesa and Diamond, 1980:524).

With reference to ethnic diversity in South Dakota, American Indians constitute the major non-white ethnic group. As far as their mortality is concerned, cancer is the third leading cause of death, responsible for 9.4 percent of all death in 1982, as opposed to 20 percent for whites (South Dakota Department of Health, 1982:45). The reasons for their lower cancer deaths are not very clear. Young et al. (1984) who studied cancer survival among ethnic groups in the United States between 1973 and 1979 and followed through December 1981. Even though they were struck by "the very low survival rates among American Indians" (Ibid.:347), they asserted that no general conclusions could be reached and suggested that, "Further analysis of differences in survival rates

among these ethnic groups [all ethnic groups in the United States] must await the accumulation of more data over time to increase the number of cases" (Ibid.:351).

The aforementioned factors do not cause cancer by themselves, but only render people more susceptible to it. The following factors have been shown to be positively correlate with cancer.

Environmental Factors

The environment in which one lives is very important in terms of exposure to cancer causing substances. In this section, we will look at industrial chemicals, as possible factors related to the onset of cancer.

Chemicals

The association between cancer and exposure to chemical substances has been documented for more than two centuries (Heidelberger, 1977:429; also Carson, 1962:220). The first such study was done by Percival Pott, who in 1775, called attention to the high incidence of scrotal cancer among the chimney sweeps in London. He attributed the cause of the disease to continual contact of the workers with coal tar (Heidelberger, 1977:430). More recently, however, the dangers of chemicals, especially poisonous agricultural chemicals, were brought

to public attention in 1962 by Rachel Carson's classic book, Silent Spring. In it, she paints a chilling picture of the destructive impacts that widespread use of chemical poisons used to control pests and insects have on people, animals, birds, and the whole ecological system.

The amount and number of chemicals produced is ever increasing. The production of synthetic organic chemicals in the United States rose from 1.3 billion pounds in 1940 to 96.7 billion pounds in 1960 and to 320 billion pounds in 1978, as a result of which some 55,000 different chemicals are now in commercial use in this country (Eitzen, 1983:329).

It is very hard and expensive to test all these chemicals for their carcinogenic effects. Due to the fact that these chemicals are produced at a relatively fast pace. But more importantly, due to the long latency period between initial exposure to a chemical and the onset of cancer, it is difficult to test these chemicals before they are marketed. Fox (1986:65-66) asserts that:

> According to an extensive study conducted by the National Research Council (NRC) and released in March 1984, there are some, 3,350 pesticides in use, and most have not been adequately tested. Toxicity data were either inadequate or nonexistent for sixty-four percent of these substances. It was concluded that fifty percent of the cancer studies and sevety-five percent of the genetic toxicity experiments

> which had been done on pesticides were flawed and unreliable. In essence, because of inadequate scientific testing and data, complete toxicity and health exposure assessments are available for only about ten percent of the pesticides and five percent of the food additives in commercial use in the United States.

Chemical substances pervade every aspect of our lives. They are found in food stuff, in the form of insecticides, herbicides, food additives and preservatives; in shampoos; in the air and water we use; etc. Of all these chemicals, at least 26 have been found unequivocally as carcinogenic in humans (Heidelberger, 1977:430; also Roth, 1985:34). Among these chemicals, some publicly known ones include asbestos, benzene, and vinyl chlorid.

Another point to mention with regard to chemicals, is the idea that there is a safety threshold of carcinogenicity. That is, since the concentration of pesticides or other chemicals in water and on food stuff is a few parts per billion, then it is "safe" and it does not constitute a significant and serious threat. However, the counterargument is that no amount of carcinogen is "safe".

As for agricultural chemicals, according to Begley et al. (1986:72):

> the use of agricultural pesticides in the United States has risen from 200,000 pounds per year in the 1950s to 1.1 billion pounds today ... less than 1 percent of the poisons reach their target pest; the rest winds up as contaminants in water, residues on produce and poisonous fallout on farm workers.

And there is reason to believe that the production and use of these chemicals will increase even more since many of the farm insects and rodents are becoming more and more resistant to chemicals designed to exterminate them. According to a recent report by the World Resources Institute, "the number of harmful insects immune to one or more pesticides reached 428 species by 1980, almost doubling the figure of 224 in 1978" (Fox, 1986:74). In addition, "20 of the worst [species of pests] are immune to everything the nation's labs throw at them" (Begley et al., 1986:73). This will make human's fight against pests for the fruits of land ineffective as evidenced by the following: "An estimated one-fifth of the nation's crops were lost to insects and other pests in 1945, before modern pesticides came into widespread use; today we still lose that much" (Ibid.). That is mainly due to the fact that these chemicals kill off the natural predators of these pests and then gradually become ineffective against the increasingly resistant pests.

In the following, a few agricultural chemicals and

their carcinogenicity in animals and/or humans are discussed. Then a few studies that have been done on the possible association of some farm chemicals and different types of cancer are reviewed.

Toxaphene is an insecticide used to kill external parasites that prey on livestock. It is a chlorinated hydrocarbon related to DDT (DDT itself has been outlawed because of its carcinogenicity). However, "Some 40-100 million pounds of toxaphane are probably used annually by farmers. According to the NCI [National Cancer Institute], this drug causes liver cancer in mice and, probably, thyroid cancer in rats" (Fox, 1986:68).

Dibromochloropropane (DBCP) is a pesticide used to combat nematodes, an enemy of fruit trees and vegetables. There has been established "a strong link between DBCP and cancer in laboratory animals (it causes stomach tumors in mice even when it is painted on their skin" (New Scientist, 1982:351). This pesticide has also been implicated in human cancers, "there was also an apparently increased rate of lymphoid leukemia in both sexes, and of oesophageal cancer among males aged 40 to 60" (Ibid.).

EDB is a fumigant used to prevent grain from becoming moldy (some molds, such as aflatoxin, are themselves carcinogenic). This substance, "which has been

in use since 1940s, was banned in 1984 because it causes cancer and birth defects" (Begley et al., 1986:73).

Artificial fertilizers have also been linked (however less emphatically) with some cancers. This is due to the fact that nitrate is an essential ingredient of artificial fertilizers and that "In the alimentary tract ingested nitrate can break down to nitrite which is a known toxic factor" (Walters, 1984:32). Under other circumstances, (such as when a person does not have natural hydrochloric acid in the stomach, which is usually the case for very young human and animal babies), the nitrite can break down still further to nitrosamines (Ibid.).

As for the relationship between nitrosamines and cancer, Walters (1984:34) reported that:

> In humans it was noticed that in Transkei there was a high incidence of oesophageal cancer among Bantu men. Here, dimethylnitrosamine was found in the fruit of a solanaceous bush, the juice of which was used to curdle milk. In Zambia, cancer of the oesophagus had been tentatively linked to the drinking of locally distilled spirits (kachasu) which contain dimethylnitrosamine at 1-3 ppm. If fed to rats this concentration would produce cancer.

In a population-based case-control study of the relationship between agricultural chemical use (by farmers) and soft-tissue sarcoma (STS); Hodgkin's disease (HD); and non-Hodgkin's lymphoma (NHL) in Kansas, Hoar et

al. (1986:1145) concluded that there was "a sixfold increase of NHL among farmers exposed to herbicides [primarily 2,4-D] more than 20 days per year". They further argue that their findings are "consistent with the sixfold excess risk associated with exposure to either phenoxyacetic acids or chlorophenols in the Swedish study" (Ibid.).

The publication of the Sweden study and the Kansas study, (which itself was undertaken to see if the conclusions reached in Sweden are applicable in the United States), helped initiate a series of studies to verify the relationship between soft-tissue sarcoma and exposure to phenoxy herbicides (such as 2,4,5-trichlorophenoxyacetic acid (2,4,5-T)) and chlorophenols (such as 2,4,5-trichlorophenol (TCP)) among chemical industry workers. Researchers argue that in the production of these herbicides, a substance called 2,3,7,8-tetrachlorodibenzo-p-dixion (TCDD), which has been found to be carcinogenic in laboratory animals, is present. Their findings provide support for the idea that phenoxy herbicides and chlorophenols are positively associated with soft-tissue sarcoma (see Honchar and Halperin, 1981; Moses and Selikoff, 1981; Cook, 1981; and Johnson et al., 1981). Others have observed increase risk of non-Hodgkin's lymphoma among those who work with these

chemicals (see Olsson and Brandt, 1981:579; and also Bishop and Jones, 1981:369).

In a study by Burmeister et al. (1983) on selected cancer mortality and farm practices in Iowa, death certificates, of white male Iowans over age 30 who died of multiple myeloma, non-Hodgkin's lymphoma, prostate and stomach cancers between 1964 and 1978, were analyzed. They found that:

> Of the six cancers [lip, stomach, leukemia, non-Hodgkin's lymphoma, multiple myeloma, and prostate] with elevated mortality in Iowa farmers, three (leukemia, non-Hodgkin's lymphoma, and multiple myeloma) are reticuloendothelial or hematological malignancies. Each of these reticuloendothelial cancers is relatively uncommon; consequently their simultaneous occurence may signify a common etioloic link. Although no single farming practice was associated with the reticuloendothelial neoplasms for each birth cohort, egg-laying chicken production, herbicide usage, and insecticide usage require further investigation...It is possible that herbicides and/or insecticides may be carcinogenic to farmers. (Burmeister et al., 1983:76).

In their study of multiple myeloma mortality among farmers in Wisconsin, Cantor and Blair (1984:253) found "elevated and statistically significant OR [Odds Ratios] among farmers resident in counties with a higher per capita inventory of chickens (OR= 1.6), fertilize use (OR= 1.7), or acres treated with insecticides (OR= 1.9). Another finding was that the incidence of multiple

myeloma was greater among the "older" farmers than the "younger" ones. This is in contrast with the finding of other researchers that the "younger" farmers have been at a higher risk, due to their more exposure to agricultural chemicals. However, they argue that "The later age at which elevated risk for multiple myeloma is seen may be related to the late age of onset of the disease or to the greater degree of differentiation of myeloma cells relative to other cell lines of B-cell origin" (Ibid.).

The literature on the association of agricultural chemicals and certain types of cancers, even though relatively consistent, is not unanimous. In their study of mortality among farmers in North Carolina during 1976-78, using death certificates, Delzell and Grufferman (1985:391) found that farmers had elevated mortality from accidents, suicides, and infectious diseases like tuberculosis, and decreased mortality from cancers of the esophagus, large intestine, and the rectum. They further concluded that in contrast to other studies, "In this study, we found no evidence of increased mortality from leukemia, non-Hodgkin's lymphoma, or multiple myeloma among white farmers in North Carolina" (Ibid.:398). They argued that this inconsistency with previous research could be due to 1) differences in agricultural practices (with North Carolina having less emphasis on corn, wheat,

and soybean production and dairying, which are widespread practices in midwestern states; 2) small period- 3 years- on which the study was based; and 3)basing occupational classification of the decedents on their death certificate, in which farming was not coded as an occupation if it was reported in conjunction with another job (Ibid.:399-400).

Blair and White (1981) studied death due to leukemia among farmer in Wisconsin. Although they found "slightly" higher rates among farmers, their conclusion was that:

> these data do not present a strong case for an association between dairy farming and leukemia because of similar findings among farmers in general and dairy farmers in particular and the likely under-representation of farmers among controls dying of smoking-related causes. (Blair and White, 1981:1030).

And finally, in the previously mentioned study by Hoar et al. (1986) on herbicide use and risk of lymphoma and soft-tissue sarcoma, whereas a positive association was established between herbicide use and non-Hodgkin's lymphoma, they did not observe an association between herbicide use and either soft-tissue sarcoma or Hodgkin's disease (Hoar et al., 1986:1141).

It should be pointed out that there are other important factors related to cancer which are out of the scope of this study. Cigarette smoking, alcohol

consumption, diet, and sexual and reproductive factors have all been shown to be related to cancer (Doll and Peto, 1981; also Rosenbaum, 1983).

Social Factors

Many social factors have also been shown to be related to mortality. The effects of income, education, and urbanization on cancer will be discussed here.

Income

Income and mortality appear to be related. Thomlinson (1965:134) asserts that "mortality is noticeably lowest for high-income groups, highest for low-income groups, and intermediate for middle-income groups". Weeks (1986:155) reports that Kitagawa and Hauser's data for 1960 show clearly that as income goes up, mortality goes down. In fact, among white families, death rates for males aged 15-64 with incomes of $10,000 or more were almost half the rates of males in families with income of less than $2,000". In the study by Devesa and Diamond (1980), the authors asserted that their finding of a reverse relationship between income and education and cancer of the cervix, further substantiated the clinical observation made in 1902 that "cancer of the cervix occurs almost exclusively among the poor" (Devesa

and Diamond, 1980:524). They further argued that "since that time, virtually all of the large cross-sectional studies have reported negative associations for cervical cancer with the use of various indicators of socioeconomic status" (Ibid.). This is so for the simple reason that better-off families can afford to spend more money on medical care and they can have access to sources of information about medical matters.

However, the relationship between income (and education) and morbidity and mortality is not always negative. In the previously mentioned study by Devesa and Diamond (1980), they observed that as far as breast cancer was concerned, "All age groups from 25 years and over to the oldest showed significant positive association with income" (Devesa and Diamond, 1980:517). They further asserted that, "The finding of strong direct association between breast cancer incidence among white females and both income and education in the TNCS [Third National Cancer Survey] is consistent with that observed in virtually all the multisite cross-sectional studies" (Ibid.).

Education

As with income, education appears to be associated with morbidity and mortality. The literature on this

issue, however consistent, is not unanimous. Many researchers indicate a reverse relationship between education and mortality, "A white male in 1960 with an eighth-grade education had a 6 percent chance of dying between the ages of 25 and 45, while for a college graduate the probability was only half as high" (Weeks, 1986:155). That is due to the fact that people with more education can learn more about health matters and avoid health dangers or be better informed about seeking help. The influence of education becomes even more important when considering the fact that education is strongly related to occupational mobility and thereby to income. According to the U.S. Bureau of the Census Statistics in 1986, the median money income of a family in which the head of the household had less than eight years of education was around $13,000, that of one with a high school diploma was around $20,000, and for those with four or more years of college, the income was close to $35,000 (Robertson, 1987:381).

This is, however, not to say that the impact of education and income on morbidity and mortality are dependent on each other. Income and education have been shown to work independently to reduce morbidity and mortality. In a study on the effects of race and socio-economic status on lung cancer incidence, Devesa

and Diamond (1983:826) asserted that, "In this study, the lack of an association with income among black females mirrors that observed among white females, whereas the decrease in risk with increasing education were more like those observed among black males ".

As for the relationship between education and cancer, researchers have not been able to come up with a clear association. In a study on the effects of socioeconomic factors and mortality, Kitagawa and Hauser (1973:81) found that, "Among the least educated younger men mortality from cancer of the lung, bronchus, or trachea [which were the largest cause of death for males] was almost twice (1.9 times) that of the best educated". They also observed that "In contrast with the inverse relationship with education shown for the other cancer sites, cancer of the prostate tended to show a positive relationship with education" (Ibid.:82). One possible explanation is that cancer of the prostate has a late onset (Burmeister et al., 1983:75) and the educated males tend to better survive other causes of death, therefore they will finally succumb to this one. In their study on socioeconomic status and cancer morbidity, Devesa and Diamond (1980:517) asserted that, "Cancer of the breast among white women also showed a strong positive association with education level". They also observed "a

correlation with education, but not with income" (Ibid.) among black females. In a study of risk factors for breast cancer, Helmrich et al. (1983:42) found that "the relative risk was 1.7 (95 percent confidence interval, 1.5-2.9) for women with >12 years of education compared to those with <12 years of education".

However, in a study on breast cancer risks among black women, Schatzkin et al. (1987:216) found that "black women with breast cancer were not more educated than the controls". They suggested that education may not translate into higher income for black women, as much as it does for white women, and its dietary and behavioral consequences.

Urbanization

Some researchers have been interested in differential morbidity and mortality from cancer in rural and urban areas. In fact, Greenberg (1983:194) reports that:

> An analysis of cancer mortality data for 52 nations suggested the view that as urbanization increases, mortality rates increase for cancer of the esophagus, intestines, lung, the lymphatic system, male rectum, and female breast cancer. Data from Poland, Norway, Canada, and England and Wales showed urban/rural differences for the expected sites.

However, in interpreting urban/rural differences, we

should exercise caution since the difference might reflect greater availability of medical services in urban areas, which in turn will result in improved detection, diagnosis, and treatment of cancer, rather than actual higher incidence of cancer.

In reviewing cancer mortality patterns in the United States, in relation to urban/rural differences, Lilienfeld et al. (1972) calculated difference ratios for different cancers. They observed that, "It is noteworthy that in the majority of instances the ratios are greater than one and moreover, they are highest for the urban/rural comparison in column (3)" [Metropolitan county with a central city compared to non-metropolitan county] (Lilienfeld et al., 1972:217). They further asserted that "Since this ratio represents the greatest contrast between urban and rural rates, the present findings confirm those previously published which suggest an increased cancer mortality in urban areas for most neoplasms" (Ibid.).

Factors associated with this increase include industrialization, high rates of smoking and drinking, diet rich in animal fat and protein and exposure to environmental pollutants. With relation to urbanization and rich diet on the one hand, and cancer mortality on the other hand, Greenberg (1983: 14) reported that a

research by Kagawa (1978) in Japan provided an interesting example. It was observed that:

> Although colon cancer rates in Japan were once among the lowest in the world, the incidence of colon and breast cancer increased two-to-threefold between 1950 and 1975, and during this same period the Japanese diet appears to have changed dramatically. The intake of milk increased 15-fold; of meat, poultry, and eggs seven and one-half fold; and of fat sixfold. During the same period, rice consumption decreased 70 percent, potato consumption 50 percent, and barley consumption about 3 percent. These dietary changes and the increase in colon cancer are reported to be most characteristic of nonfarmers, city dwellers, and the wealthy.

However, other researchers studying cancer mortality differences between urban and rural areas, have come up with different conclusions. In a study on "Changing Patterns of Lung Cancer in the United States", Blot and Fraumeni (1982) did not find a significant urban/rural difference. They observed that "urban/rural ratios in rates within the north and south diminished over time, and by the 1970s the age-adjusted mortality rates among white males in small (population <25,000) southern counties had nearly equalled those in large (population >250,000) counties in the northeast" (Blot and Fraumeni, 1982:665).

Greenberg (1984) in reviewing the literature on cancer mortality patterns claimed that urban/rural cancer

rates are more and more converging. He asserted that, "In 1950-54, the white male cancer mortality rate of the 293 most urban counties in the United States was 35 percent higher than the rate in the more than 2,000 rural counties. In 1970-75, the difference has shrunk from 35 to 12 percent" (Greenberg, 1984:146). And as for the differences between white females, he asserted that even though the differences were less than the differences among white males, "but nevertheless they decreased from 16 percent in 1950-54 to 12 percent in 1970-75" (Ibid.). He argued that this smaller difference might be due to higher rates of urban female respiratory cancers which has occurred in some central cities such as Houston, Texas or Los Angeles and San Fracisco, California, where women picked up cigarette smoking sooner than rural women. However, he offered four possible reason for the general convergence pattern:

1) Because cancer tends to be under-reported as a cause of death, and this is more so in rural areas than in urban areas. The increase in rural cancer could reflect more recognition of cancer by physicians.

2) Urban people could be moving to rural areas as they get old and die of cancer in rural areas.

3) There has been improved survival in urban areas, since many rural areas have relatively few physicians and

poorer medical equipment for diagnosis and treatment of cancer.

4) The rural environment has changed. Since consumption patterns in rural areas have become more like urban areas, and industrialization, automobile and other major sources of environmental pollution have spread to the rural areas (Greenberg, 1984:149-150).

Summary

The ascendancy of cancer to the second position as a cause of death has stimulated extensive interest in its causation. Cancer mortality is, of course, a complicated issue, since the latency period can be very long and many factors can influence each other in the course of cancer development. However, research has been able to narrow the seemingly unlimited factors related to cancer. Among these factors, age, sex, environmental exposure, and socio-economic factors have been shown to be definitely related to cancer. However, the conclusions reached are not always in accordance with what has been done previously, thus making more research on the subject an important enterprise.

CHAPTER THREE

THEORETICAL MODEL

Introduction

This study looks at the association between certain social and environmental variables and cancer mortality in South Dakota from 1960 to 1980, "but science must do more than point out and describe variations in the world. The ultimate goal is to understand how phenomena or events are related to each other" (Turner, 1982:5). Establishing relations among phenomena is, among other things, what theory does. A theory, according to Kerlinger (1973:9) is:

> A set of interrelated constructs (concepts), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena.

A theory seeks to explain events by finding the connecting thread that binds the events together. However, in the process of finding commonalities that apply to different events, theory becomes detached and abstract from the particularities of single events. On the other hand, a theory provides one with a framework by which one can manage and understand phenomena. That is, events in the society and the world are so diverse and seemingly unrelated that unless one has some kind of sensitizing mechanism(s), one can hardly make sense of

all the things that happen. However, an important characteristic of theoretical statements is that "they are created to be proven wrong" (Turner, 1982:11). If a theory, or aspects of it, can not be tested (usually through propositions and hypotheses) against the facts of real world, it loses its scientific importance and becomes "a self-sustaining dogma which is accepted on faith" (Ibid.:12).

In this chapter a brief review of theoretical perspectives relevant to the problem is presented. This is to provide a proper framework in which the data can be analyzed and interpreted.

Mortality rates, as indicated before, have fallen during the past century. They fell as a reaction to the rising standards of living and later to improvements in medical technology and care of the patient. That is, modernization played a major role in the control of many diseases and the subsequent mortality decline. There also occurred in this process a shift in mortality and health patterns in which infectious diseases were displayed by degenerative ones as major causes of illness and death.

Factors Affecting Mortality Decline

In delineating factors associated with mortality decline, following Nam and Philliber's model (1984),

these factors were categorized as macro and medial factors. (Nam and Philliber also had a micro level, but since this study focuses on planning district as the unit of analysis, micro level factors were not considered).

Macro Factors

Macro level factors are global factors whose influences are understandable on the societal level as a whole, even though their effects on particular families and individuals may be negligible. Of these factors, modernization and improvements in medical technology were considered. These factors provided the overall framework within which the study is conducted. One point to mention is that in the discussion on these factors, references are sometimes made to studies about mortality trends in England. This is because most historical analyses of mortality trends treat Europe and the United States in one category because "The experience of the American population has been generally comparable to that of Europeans, although there is some evidence that during the eighteenth and nineteenth centuries, mortality was slightly lower in the United States than in Europe" (Weeks, 1986:169).

Modernization and Technological Change

The issue at hand is, generally speaking, one of societal development and its consequences. Although discussed under rubrics such as economic development, industrialization, and social and economic growth, modernization is viewed as a general process that involves economic growth along with social and cultural development (Lauer, 1973:210). There is some argument about which term is more accurate than the rest, or as to the specific areas (economic, political, or cultural) to which a particular term should be applied. For example, it is sometimes argued that the term "modern" should not be used unless the criteria of "modernity" are clear (see Chodak, 1973). For purposes of this research, the concept of modernization is used because modernization is, according to Vago (1980:145):

> a more comprehensive term that subsumes industrialization and other concepts such as economic growth or development and the political, social, religious, educational, and other institutional changes that accompany industrialization.

Modernization is a pervasive phenomenon, for it touches all aspects of life and society. This is so asserted because the notion of society presented here is one of a system. That is, society is conceived "not simply as congeries of individuals or elements or

constituents or units" (Chodak, 1973:6), but as a whole comprised of different parts that are mutually interdependent, whereby a change in one part will bring about changes in other parts. In this juncture, the view of society taken in this research should be distinguished from those of structural functionalism and conflict theories.

Structural functionalism, especially the Parsonsian tradition views society as an organism, much like a human body and emphasizes the relationship among the various parts of society and the need for integration in the maintenance of society. In this view, society consists of interdependent parts, each of which plays a function, or many functions that help maintain the stability of the entire system. The system as a whole, however, has a tendency to constantly seek equilibrium or balance. That is, although society is never perfectly integrated and there are always strains and tensions between the various parts, but there are institutions and mechanisms by which society manages and controls these strains, thereby keeping its equilibrium or regaining it when disturbed (Robertson, 1987:517). In this view, therefore, when one part of society changes, it disrupts society's equilibrium and the society makes changes in other parts to regain its equilibrium.

In conflict theory,particularly the Marxian tradition, the economic system (the means of production, to be precise) in a society constitutes the infra-structure on which all other institutions of the society, such as family and religion, that make up the super-structure, are built. When a change occurs in the economic system, that forces other institutions to change and adapt themselves to the new state of the economy. Although it is possible that the institutions in the super-structure influence and cause change in the economic system (Ritzer, 1983:116), the direction of change is, most often, from the economic system to other institutions (Marx, 1859).

In the conception of society presented in this research, it is not implied that societies are in a state of "equilibrium or homeostasis", or that changes are made for the preservation of the whole (as the functionalists would do), nor that the changes of one part (or some parts) are dependent on the changes of another structurally more important part (as conflict theorists might do). It is simply asserted that as societies become more complex, differentiated, and specialized, different parts become more and more dependent on other parts, and therefore are more vulnerable to the impact of changes in other parts. This vision of society, on the other hand,

is congruent with both structural functional and conflict theories of society without taking the judgmental approach of either one. Neil Smelser (1968) contends that as a society modernizes, different realms of society often undergo simultaneous change:

> (1) In the realm of technology, the change from simple and traditionalized techniques toward the application of scientific knowledge. (2) In agriculture, the evolution from subsistence farming toward commercial production of agricultural goods. This means specialization in cash crops, purchase of nonagricultural products in the market, and frequently agricultural wage-labor. (3) In industry, the transition from the use of human and animal power toward industrialization proper or 'men aggregated at power-driven machines working for monetary return with the products of the manufacturing process, entering into a market based on a network of exchange relations.' (4) In ecological arrangements, the movement from the farm and village toward urban centers (Smelser, 1968:126).

As far as morbidity and mortality are concerned, improvements in agricultural techniques drastically increased the quantity and variety of food, which was made available to more people with improvements in transportation. This in turn increased people's resistance to many infectious diseases. In their study of mortality decline in England and Wales during the nineteenth century, McKeown and Record (1962) came to the conclusion that:

> in order of their relative importance, the influences responsible for the decline of mortality in the second half of nineteenth century were: (a) a rising standard of living, of which the most significant feature was improved diet (responsible mainly for the decline of tuberculosis and less certainly, and to a lesser extent, of typhus); (b) the hygienic changes introduced by the sanitary reformers (responsible for the decline of the typhus-typhoid and cholera groups); and (c) a favorable trend in the relationship between infectious agent and the human host (McKeown and Record, 1962:120-1).

There were other factors that contributed to the decline in mortality. The ability to control temperature and humidity at home and place of work helped restrain respiratory infections. Public sanitation, water purification, and sewage disposals contributed to the decreased spread of infectious diseases (Thomlinson, 1976; also Omran, 1980). Milk sterilization and pasteurization helped control bovine tuberculosis and ecteric diseases. Improvements in housing (ventilation and sewage disposals) and personal and domestic cleanliness (increased use of soap) helped discourage flies, mosquitoes and therefore decreased sickness due to germs transferred by these insects (Omran, 1980).

Improvements in Medical Technology

Another factor at the macro level responsible for the decline in mortality was improvements in medical

science and technology. It is asserted that control of infectious diseases was greatly advanced through mass immunization and the development of bacteriology. That is, the "prevention and cure of infections through asepsis (protection against bacteria) and antisepsis (inhibition or destruction of bacteria); vector control (the elimination of disease-carrying pests at points where they breed)" (Nam and Philliber, 1984:75), helped control the devastating effects of many infectious diseases. It should be noted that the relative importance of medical advances in accounting for the decline in mortality, as compared to the influence of rising standards of living, is a matter of dispute among scholars. Omran (1982) and McKeown et al. (1975) argued that medical innovations started to appear during the early part of twentieth century and therefore were of secondary importance. It is asserted that these innovations were more important in keeping the death rates down in the twentieth century. As far as the substantial mortality decline of the nineteenth century is concerned, "it is probable that only within this [twentieth] century have medical men and surgeons helped more people than they have injured, one might almost say, cured more persons than they have killed" (Conant in Thomlinson, 1976:102). One of the consequences of these

changes was that during the late nineteenth century and early twentieth century and after some time had elapsed since the onset of mortality decline, fertility also started to decline, resulting in an increase in population. Also in this period, a slow rise in degenerative diseases occurred in some countries (Omran, 1983:306). This historical change is described by "Epidemiologic Transition Theory".

Epidemiologic Transition Theory

The epidemiologic transition theory, as put forward by Abdel R. Omran (1971, 1980, 1983) asserted that when societies undergo a shift from low to higher standards of living as a result of social and economic changes due to modernization, a shift in their patterns of health and disease will also occur. The shift is that infectious and communicable diseases (like typhoid, tuberculosis, cholera, etc.) are gradually displaced by degenerative diseases (such as heart diseases, cancer, stroke, diabetes, and the like) as the primary causes of morbidity and mortality.

A major assumption of this theory is that mortality "is a fundamental factor in population dynamics with fertility as a significant co-variable" (Omran, 1983:305). This is so because whereas fertility is

limited in its range of fluctuation (due to biological reasons, age at marriage, etc.), mortality has no fixed upper limit, and "even if fertility approached its biologic maximum, depopulation could, and did, occur as a result of epidemics, famines, and wars which repeatedly pushed mortality levels to high peaks" (Omran, 1983:305).

Based on the pace and determinants of the transition, there are three basic models of the epidemiologic transition. The Classical or Western Model, the Accelerated Model, where abortion played a major role in birth control, and the Delayed Model, where mortality has declined, but fertility is still high. The Classical or Western model was considered as appropriate for describing South Dakota's transition and is discussed below.

Classical or Western Model

This model describes the transition in western countries during the past 200 years. In these countries, both mortality and fertility declined slowly (although fertility decline started later). Mortality and fertility declines were gradual and took place as a response to and along with socio-economic and environmental developments that happened as a result of modernization, and in later stages of the transition, medical innovations. The three

stages of epidemiologic transition, as they exemplify the transition in the West are discussed below.

1) The Age of Pestilence and Famine was when fertility was high and mortality was also high and fluctuating, thus precluding a sustained population growth. In this stage, famine, malnutrition, lack of sanitation, and different types of infectious diseases were major causes of mortality. A study by Graunt shows that "nearly three-fourth of all death in London were attributed to infectious diseases, malnutrition, and maternal complications" (in Omarn, 1983:306). Life expectancy was short, between 20 and 40 years. In the United States for example, during 1824 and 1902, "scarlet fever, which is now an extremely mild and nonfatal disease, was unusually rife during most of the 19th century" (Omran, 1980:16). However, a major difference in this stage between the United States and Europe was the "virtual absence of famine" (Ibid.) in the United States, which was a major cause of death in Europe.

2) The Age of Receding Pandemics is when mortality declined progressively as pandemics decreased in frequency and magnitude, and infectious diseases started to decline. This decline was basically a consequence of modernization and rising standards of living.

3) The Age of Degenerative and Man-made Diseases was

the stage in which mortality continued to decline and stabilized at a low level. This low mortality was due to high levels of living and the medical innovations of the 20th century. Life expectancy at birth rose to the 70s in this stage. However, diseases like cardiovascular diseases, cancer, stroke, and diseases introduced by humans such as accidents, radiation injuries, carcinogens in the environment and in industry, and food additives, became major causes of illness and death at this stage. An increase also took place in stress related illnesses, such as mental illness and drug dependency. These diseases progressively replaced infectious ones as primary causes of death. This stage became more prominent after World War I in western countries (Omran, 1983: 307).

Medial Factors

Medial factors refer to "influences that operate through institutions of the community or group attachments of the individual" (Nam and Philliber, 1984:3). These factors are important because the macro factors (economic development and modernization) often operate through these medial variables to effect the individual. Of these factors, urbanization, and education are discussed.

Urbanization

Urbanization in America as "the process by which population is concentrated in cities" (Robertson, 1987:576) was one of the consequences of modernization. Even though cities existed before industrialization,

> large-scale urbanization had to await the Industrial Revolution, which led to highly developed facilities for road, rail, sea, and advanced technologies for storage by such means as canning, refrigeration, and the use of chemical preservatives (Ibid.).

This is due to the fact that a city is "a permanent concentration of relatively large numbers of people who do not produce their own food" (Ibid.) and have to depend on the farm products that have to be transported to and stored in cities. This could not have happened if modernization had not made transportation and storage possible. Furthermore, with the establishment of most factories in the cities, rural people had to migrate to the cities in search of jobs.

Some scholars have emphasized the negative effects of the process of urbanization. Louis Wirth (1938 in Robertson, 1987:582) asserted that with the three characteristics of urbanism (increased size, density, and heterogeneity) also came the formalization of relationships, decreased allegiance to traditional values as a result of awareness of other values, and anomie. All

these in turn "fostered high levels of nervous stimulation, psychological overload, and social isolation in the population aggregate" (Miller et al., 1982:639), which are not necessarily health producing elements. On the other hand, urban areas have better and more medical care facilities. With reference to urban/rural differences in medical care resources, Miller et al. (1982:638) observed that:

> In 1973, the physician population ratio (per 1,000) was 1.5 for metropolitan areas compared to .67 for the nonmetropolitan areas. If a more specific breakdown is used, the differential in 1976 is even more pronounced. Core metropolitan counties had an average of 2.7 physicians per 1,000 population; thinly populated counties (those with less than 2,500 urban residents) had a ratio of .39, a difference of over 600 percent.

As for the association between urbanization and morbidity and mortality, the literature suggests that the relationship reflected a U-shaped curve. That is, in the early stages of urbanization, due to high population density, lack of public sanitation, the improverished state of health care, and exposure to industrial chemicals and fumes, mortality in urban places, especially due to infectious diseases, increased. However, later, as the state of health improved, urban mortality due to infectious diseases decreased to become lower than that of rural areas. But when the benefits of

modernization reached the rural areas and controlled mortality due to infectious illnesses there as well, urban mortality due to degenerative diseases made urban mortality higher than rural mortality. This was basically a result of "the concentration of such important risk factors in cities as industrialization, high rates of smoking and drinking, a Western-world diet, Western medical practices, worker exposure to dangerous substances, and environmental degradation" (Greenberg, 1983:4; also Fraumeni, 1975).

Education

Another consequence of modernization was a gradual increase in the population's education. According to Brinkerhoff and White (1985:321):

> During the last 2 centuries, industrialization and urbanization have transformed the U.S. institution landscape. Two major long-term trends in education during this period are a shift from elite to mass education and increasing bureacratization.

Before the nineteenth century, education was basically limited to the wealthy. Actually, the word "school" is derived from an ancient Greek word meaning "leisure" (Robertson, 1987:375), and that is because only the rich could afford the time and money to pursue education and "cultivation of the mind" (Ibid.). Much of

this education was not vocational in nature, rather it was to learn literature. Many of these schools "were church-sponsored, and their programs focused on reading, particularly the Scriptures" (Brinkerhoff and White, 1985:321).

However, during the years of industrialization and modernization, mass education came to be viewed as necessary and desirable. Children and adolescents were gradually eased out of labor force and into schools, partly because of the belief that education will assist children of the working-class families escape their parents poverty, and also to keep cheap labor of the children out of labor market (Ibid.:322).

It should also be pointed out that an industrial society needs a relatively educated labor force with the appropriate education to accomplish assigned tasks, such as reading directions on machines and operating them. All these led to an increase in the number of people attending schools and also an increase in their level of education. So, it was during the 1930s that secondary education became common and it was not until after World War II that high school graduates continued on to college. In fact, according to Robertson (1987:376):

> In 1900, about 7 percent of Americans in the appropriate age group were graduated from high school;...more than two-thirds of the present American population has a high school

> diploma;...the proportion of high school graduates attending college has also risen steeply, from 4 percent in 1900 to 16 percent in 1940 to about 40 percent by the late 1980s.

As far as the relationship between education and morbidity and mortality is concerned, it should be mentioned that education, like income, does not by itself "cause" cancer, however, it makes possible certain kinds of behaviors that have a bearing on developing cancer. For example, more and better education can make people more informed about diseases and ways to avoid them or how better to seek help when afflicted with a disease. This influences the decrease of non-degenerative diseases on the one hand, but on the other hand, can also increase the incidence of degenerative diseases by letting people live longer, so their bodies deteriorate. It also allows more time to be exposed to carcinogens.

Demographic Consequences of Modernization

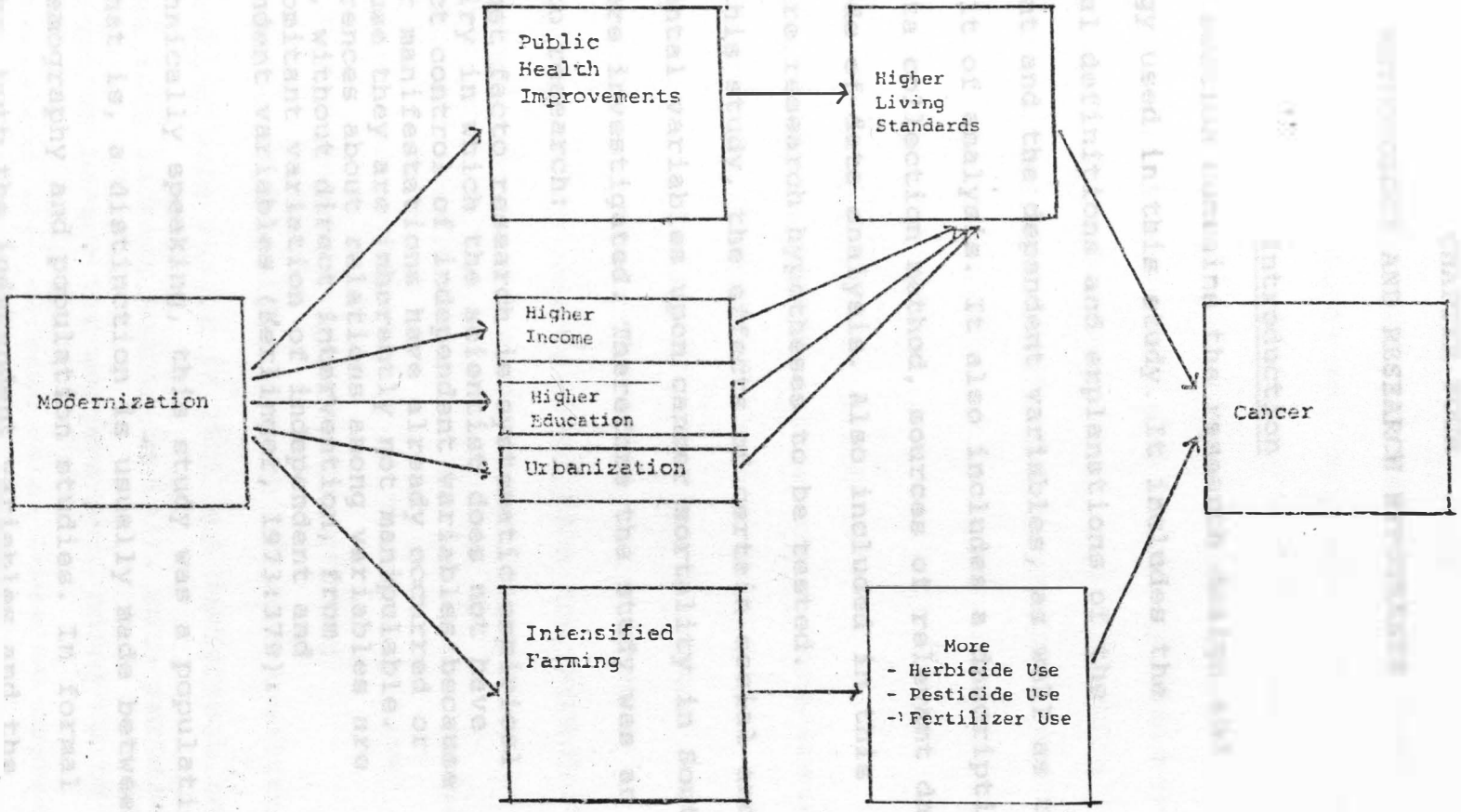
Modernization had an impact on many aspects of society. First, the shift from infectious diseases to degenerative ones changes the average age at death. Most infectious illnesses prey on the young and wherever they are prevalent, life expectancy is short (30-40 years). Degenerative diseases, however, are illnesses of old age and wherever they prevail, life expectancy can reach 70

years or more. Second, with declining fertility, childbearing became less frequent. That, with improvements in child delivery, helped decrease female mortality. This then led to more female senior citizens (Cowgill, 1963; also Omran, 1980). Third, the transition was slower among the non-white population of the United States than among the whites. This was due to the fact that whites "have always been better off than nonwhites with regard to housing, education, living standards, social and economic levels, nutrition, access to medical care, and other cultural and demographic characteristics" (Omran, 1980:33). This resulted in lower death due to infectious diseases and higher death due to degenerative diseases among the whites.

Summary

As societies industrialize, they also become structurally more differentiated. Different parts of the society become more interdependent, and consequently, more vulnerable to the changes in other parts. In the United States, with industrialization also came changes in standards of living, education, and urbanization, all of which affected the health and mortality patterns. That is, degenerative and chronic diseases replaced infectious illnesses as major causes of illness and death.

THEORETICAL FRAMEWORK



CHAPTER FOUR

METHODOLOGY AND RESEARCH HYPOTHESES

Introduction

This section contains the research design and methodology used in this study. It includes the operational definitions and explanations of the independent and the dependent variables, as well as that of the unit of analysis. It also includes a description of the data collection method, sources of relevant data, and methods of data analysis. Also included in this chapter are research hypotheses to be tested.

In this study, the effects of certain social and environmental variables upon cancer mortality in South Dakota were investigated. Therefore the study was an Ex Post Facto research:

> Ex post facto research is systematic empirical inquiry in which the scientist does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables (Kerlinger, 1973:379).

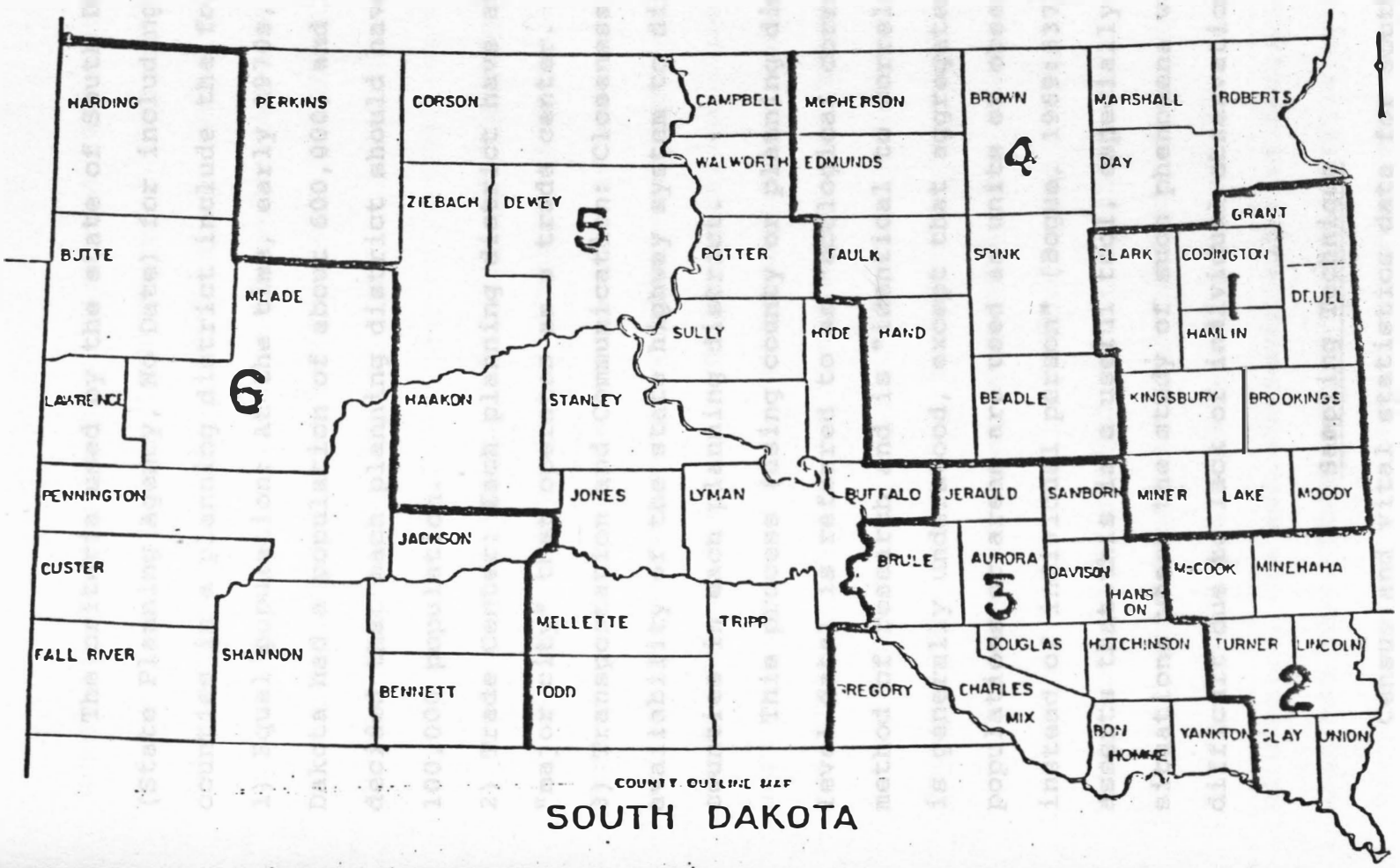
Technically speaking, this study was a population study. That is, a distinction is usually made between formal demography and population studies. In formal demography, both the independent variables and the dependent variables are demographic in nature, like the

relationship between fertility and age and sex specific characteristics of a population. In population studies, either the independent variables or the dependent variables are non-demographic in nature, like the relationship between education and fertility (Kammeyer, 1971). In our study, the independent variables were non-demographic, whereas the dependent variable was demographic.

The Unit of Analysis

The unit of analysis in this study was the state planning district. Ideally the county should have been selected because it is a recognized governmental unit, and also because of the availability of reliable secondary data on the county level from the United States Bureau of the Census, and South Dakota Department of Health. However, the numbers for the dependent variable (cancer death) were very small at the county level, becoming insignificant for analysis purposes.

There are 66 counties in South Dakota. Armstrong and Dewey counties were merged in 1951 and Washabaugh county was merged with Jackson county in 1979. Data pertaining to the counties before the mergers were added up to become consistent with current data. These 66 counties were broken into six planning districts (next page).



COUNTY OUTLINE MAP

SOUTH DAKOTA

The criteria used by the state of South Dakota (State Planning Agency, No Date) for including different counties in a planning district include the following:

1) Equal population: At the time, early 1970s, South Dakota had a population of about 600,000, and it was decided that each planning district should have about 100,000 population.

2) Trade Center: Each planning district have at least a "major city" that operates as a trade center.

3) Transportation and Communication: Closeness and availability of the state highway system to different counties in each planning district.

This process (using county or planning district level data) is referred to as "ecological correlation" method of research and is "identical to correlation as it is generally understood, except that aggregates, populations or areas are used as units of observation instead of individual person" (Bogue, 1969:537). Bogue asserts that this is a useful tool, especially in situations where the study of such phenomena would be difficult due to lack of individual observations (Ibid.).

Sampling Technique

Census and vital statistics data for South Dakota counties were used. Pertinent data for ten year

intervals, ending in 1960, 1970, and 1980 were taken as well as data for the single years of 1960, 1970, and 1980. Agricultural chemical data were taken from the 1959, 1969, and 1978 Census of Agriculture. County data were added up and averaged to obtain planning district data.

Operational Definition of Variables

In this study the independent variables were use of agricultural chemicals, economics, urbanization, and education. The dependent variable was South Dakota cancer death rates for 1960, 1970, and 1980. Sex, age, and race were treated as control variables. Below, an operational definition is given for each of these variables.

Chemical Use

This variable was measured by the amount of chemicals (fertilizer, pesticide, and herbicide) used, or number of acres treated with a specific chemical. Ideally, pounds per acre use of each of these chemicals for each county should have been used. However, tonnage of chemical use was available only for fertilizers for 1959 and 1969. Therefore, for 1978 fertilizer use, and for all years for pesticide and herbicide use, percent acres of county farmland treated were used. One point to

mention in this regard is that the data on pesticides and herbicides was reported by the kind of crops, pests, or insects (and the number of acres) on which the chemical was used. For the purposes of this study, these chemicals were considered under the two general terms, pesticides and herbicides, and acres that were treated were added up to obtain a total number of acres treated for each county. This would result in some overlap of acres, because some acres might be counted more than once. However, it was felt that since exposure was the focus, and it is very likely that the same land area could be treated with different chemicals, therefore, it did not matter if the same acres were counted more than once. It should also be pointed out that for 1959, no county data on pesticide and herbicide use was reported, therefore, the analysis for that year was based only on fertilizer use.

Economics

County median family income and county percent of poverty families (families with incomes less than the poverty level) were taken as indicators of a county's economic status. It should be mentioned that the category of poverty families did not exist in 1960, therefore, only county median family income was used for that year.

Education

County median education was used for 1960 and 1970 since the data were reported by the Census as "Median School Years Completed" for "persons 25 years old and over" (Census Bureau, 43C:120). However, for 1980, the data was reported as "Percent High School Graduates (Persons 25 and Over) (Riley et al., 1983:29).

Urbanization

This variable was measured using the Census definition of urbanization. That is, an urban population includes "all those people living in incorporated and/or census designated places of 2,500 or more inhabitants and other territory, incorporated or unincorporated, included in urbanized areas" (Ibid.:37). Utilizing this definition, county percent of urban population was obtained.

Death Rates

Two sets of data were used. In one set, utilizing the ninth revision of the International Lists of Diseases and Causes of Death (ICD), all cancer sites were aggregated into ten general groups: (1) oral cavity and pharynx; (2) digestive organs; (3) respiratory organs; (4) breast; (5) genital organs; (6) urinary organs; (7)

connective tissues and nervous system; (8) leukemias; (9) lymphatic tissues; and (10) other and unspecified ccancers.

There are advantages and disadvantages to this aggregation. The disadvantage is loss of specificity. That is, by classifying a cause of death as respiratory cancer rather than larynx, pluera, or middle ear, one might make the association between a cancer and its cause(s) more vulnerable to confounding factors.

The advantage of aggregating data is increasing the reliability of the data. That is, since cancer is an invasive disease, normal boundaries of adjacent body sites could be disrupted and sites could be misclassified as the primary cause. Greenberg (1983:34) reported that:

> Baker (1980) suggests that the high white male pancreatic cancer mortality rate observed in St. Louis County, Minnesota, may be due to incorrect classifications. Perhaps stomach cancer was the correct diagnosis, a possibility supported by the observation that the northern Minnesota region has among the highest stomach cancer mortality rates among whites.

Greenberg further commented that in the above situation, digestive cancer instead of pancreatic or stomach cancer could have been a wiser classification (Ibid.).

It should be mentioned that cause-specific mortality data for all the individual years from 1951 to

1980 were not available to us. Therefore a cause-specific analysis for all years was not performed.

Yearly sex and race mortality due to cancers were added up for the three ten-year groups of 1951-1960, 1961-1970, and 1971-1980, and then were turned into rates. This was done due to the fact that the number of deaths for each year were not large enough to be statistically significant. Furthermore, by aggregating time periods and places (counties), the influence of population migration and latency period of cancers could be reduced (see Polissar, 1980; also Greenberg, 1983).

Statistical Analysis

Multiple regression analysis was used to determine how much of the variability of death rates could be significantly predicted by the variability of social and environmental variables tested. This procedure will allow for assessing the relative contribution of each of several independent variables having an influence on the dependent variable. The Leaps and Bounds procedure (SAS Inc., 1985) was used. This procedure first examines single predictors against the dependent varible(s), starting with the one the explains the most, and then the second highest one, and so on, until all, unless otherwise specified, independent variables are

considered. Then, sets of two predictors are considered in relations to the dependent variable(s), again starting with the set with the highest amount of explanation, then the second highest, and so on. This procedure is repeated for sets of three, and four and more predictors until all of independent variables are considered in one category. Pearson correlation coefficients were also calculated for hypothesis testing. The .05 level of significance was utilized in this study. The dependent variable was cause-specific cancer death rates by region for single years of 1960, 1970, and 1980.

Hypotheses

Null Hypothesis

The following null hypothsis is considered.

H0. There is no relationship between the selected social and environmental factors and cancer mortality in South Dakota by planning district.

Research Hypotheses

Farming

As a result of modernization, farming became more mechanized and commercialized. That is, to increase its production, it relied more on chemicals, many of which have been shown to be carcinogenic. Furthermore, a number of studies have shown that those who were exposed to

these chemicals have shown increased mortality from certain cancers, therefore:

H1. The greater the percent of acres treated with herbicides in a planning district, the greater the rate of death due to lymphatic tissue cancer in that planning district.

H2. The greater the percent of acres treated with pesticides in a planning district, the greater the rate of lymphatic tissue cancers mortality in that planning district.

Education

Education, as mentioned in the literature review, has been shown to have a reverse relationship with mortality due to some cancers and a direct relationship to mortality due to some other cancers, therefore:

H3. The higher the education level of a planning district, the greater the rate of mortality due to genitory organs cacners in that planning district.

H4. The higher the education level of a planning district, the higher the mortality rate due to breast cancer among females in that planning district.

Economics

Economic development and an increase in income usually occur with modernization. Research evidence indicates that income influences mortality by changing diet and making health care more available, hence:

H5. The higher the planning distirct's median family income, the higher the rate of female breast cancer mortality in that planning district.

H6. The higher the planning district's percent of poverty families, the higher the rate of female cervix cancer mortality in that planning district.

Urbanization

Urbanization has also been associated with some cancers. That is, life situations and work conditions are different in urban areas, making some cancers more prevalent in urban areas.

H7. The more urbanized a planning district, the higher the rate of respiratory cancer mortality in that planning district.

H8. The more urbanized a planning district, the higher the rate of digestive cancer mortality in that planning district.

CHAPTER FIVE

FINDINGS AND ANALYSIS

Introduction

This chapter presents a review and interpretation of the findings and interprets the findings in light of the literature and theory presented in previous chapters. As outlined in Chapter One, this study had two objectives:

1) To describe patterns that have developed in cancer mortality over time.

2)) To investigate if there is an association between social and environmental factors and cancer mortality.

Data pertinent to the first objective are reported both at the state and planning district levels. Data regarding the independent variables are presented first.

Descriptive Findings

State Level Data

Independent Variables

This study employed four categories of independent variables; economics, urbanization, education, and agricultural chemical use. Table 1 summarizes the state data for all variables.

TABLE 1

ECONOMIC, URBANIZATION, EDUCATION AND AGRICULTURAL CHEMICAL USE FOR SOUTH DAKOTA FOR 1960, 1970, AND 1980

Variables	1960	1970	1980*
Median Family Income	$4,251	$7,494	$15,993
Percent Poverty Families	NA**	14.8	13
Percent Population Urban	39.3	44.6	46.4
Median Education Level			
(MSYC)***	10.4	12.1	0
(PHSG)****	0	53.3	67.9
Percent Acres T/W@ Fertilizers	1.7	7.6	11.6
Percent Acres T/W Pesticides	0	1.1	3.8
Percent Acres T/W Herbicides	0	7.2	12.2
Counties W Zero Urbanization	43	43	43

* 1978 Agriculture Chemical data.
** Not Available.
*** MSYC = Median School Years Completed.
**** PHSG = Percent High School Graduates.
@ T/W = Treated With.

Economics

As can be observed from table 1, state median family income has increased from 1960 to 1980. In fact, it has almost doubled from one decade to the next. But the percent of poverty families has decreased since 1970.

Urbanization

With reference to urbanization, it should be pointed out that even though the percent of urbanization, at the state level, has increased, the number of "urban" counties has not changed. That is, there were 43 counties with zero percent of urban population in 1960, 1970, and

1980. However, whereas Stanley county lost its "urban" status from 1960 to 1970, Shannon gained such status during that period, and Brule county lost its "urban" status from 1970 to 1980. Therefore, the increase in South Dakota's urban population resulted from the fact that those few counties that were urbanized became more so.

Education

South Dakota's educational attainment has also increased. However, as mentioned in Chapter Four, the data for 1960 was reported as the median school years completed for those 25 and over. For 1980, it was reported as percent of population, 25 and over, with high school diploma, and for 1970, it was reported in terms of both criteria. Since the data for 1960 and 1980 could not be compared, 1970 data was used as a bridge to see the pattern of education through the three decades.

Agricultural Chemical Use

For agricultural chemical use, three indicators (fertilizer, pesticide, and herbicide use) were employed. For purposes of comparison, percent of farm land treated with each of these chemicals was obtained, and as can be seen from table 1, they all have increased substantially.

Dependent Variable

Cancer mortality was the dependent variable in this study. Pertinent data for this variable are reported in three tables. First, data for each one of the cancer categories for each of the single years (1960, 1970, and 1980) are reported in table 2. In table 3, sex and race-specific cancer death rates for each cancer category are presented. However, here cancer death rates are for ten year periods ending in 1960, 1970, and 1980. In table 4, age and sex-specific cancer mortality rates are presented. In this case, the data is for each single year.

TABLE 2

SOUTH DAKOTA CANCER DEATH RATES* BY CANCER CATEGORIES FOR 1960, 1970, AND 1980

Cancer Category	1960	1970	1980
Oral Cavity and Pharynx	.018	.034	.025
Digestive Organs	.503	.496	.543
Respiratory Organs	.185	.293	.369
Breast	.035	.141	.165
Genital Organs	.261	.272	.216
Urinary Organs	0	.099	.090
Connective Tissue/Nervous Sys.	.331	.143	.182
Leukemias	.088	.096	.072
Lymphatic Tissues	.073	.078	.116

* Deaths per 1,000 population.

As can be observed, death due to respiratory, breast, and lymphatic tissues cancer have consistently

been increasing. Connective tissue and leukemia declined from 1960 to 1970, but then had an increase in 1980.

Table 3 (next page) presents a more precise picture of the patterns with respect to different cancer categories. As can be observed from table 3, digestive system cancer death rates for both sexes decreased from 1960 to 1980. However, the decrease took place essentially among whites and was smaller for white males.

Respiratory cancer death rates increased for both sexes of both races, even though the figures for non-whites were very small. White males had an increase of 132.7 percent from 1960 to 1980. The increase for white females was 106 percent during this period.

Breast cancer rates also had a consistent increase during the three decade period. There was no incidence of breast cancer among non-white males, and the incidents for white males and non-white females were very small. White females had an increase of 39.5 percent from 1960 to 1980.

Death due to lymphatic tissues cancer also showed a consistent increase. There was a 39 percent increase from 1960 to 1970 and a 15 percent increase from 1970 to 1980 for white males. The increase for white females, even though smaller in sheer numbers, was 52 percent from 1960 to 1970 and 18 percent from 1970 to 1980. The incidence

of this cancer among non-whites was very small.

There also was a consistent, however small, increase for death due to genital organs cancer. The increase was basically among whites and was relatively the same for both sexes.

Age and sex-specific cancer death rates are presented in table 4.

TABLE 4

AGE AND SEX-SPECIFIC CANCER DEATH RATES* FOR SOUTH DAKOTA FOR 1960, 1970, AND 1980

Age Groups	1960		1970		1980	
	M	F	M	F	M	F
0 - 49	.2	.3	.2	.2	.2	.2
50 - 54	1.6	2.6	1.4	2.0	1.6	2.5
55 - 59	2.3	2.7	3.2	3.1	2.5	2.6
60 - 64	4.1	3.9	4.8	3.5	4.6	3.9
65 - 69	6.9	4.3	6.9	3.4	6.4	5.7
70 - 74	8.5	5.6	11.1	4.0	11.6	6.0
75 - +	15.6	10.2	14.5	9.3	15.1	10.3

* Deaths per 1,000

Since cancer deaths in ages prior to 50 were very rare, it was felt appropriate to collapse all those years into one category, without biasing the results in any direction. As could be observed from table 4, death due to cancer increased steadily with advances in age. One striking point is that death rates in age categories prior to age 70 and 75 increased in "small" increments.

However, there appears to be a clear jump from age 70 and 75 onwards. This holds true for all the years and for sexes.

Regional Level Data

Independent Variables

Economics

Regional economic figures are presented in table 5.

TABLE 5

SOUTH DAKOTA REGIONAL ECONOMIC DATA FOR 1960, 1970, AND 1980

	Region / Year	1	2	3	4	5	6
MFI	1960	3475	3839	3209	3504	3933	4458
	1970	6619	7107	5950	6593	6667	7185
	1980	13790	16491	12842	13378	13179	14987
PPF	1960	0	0	0	0	0	0
	1970	15.2	15.8	22.9	17.0	22.5	18.4
	1980	15.5	11.3	20.2	17.8	23.4	18.1

MFI = Median Family Income (dollars).
PPF = Percent Poverty Families.

As can be observed from table 5, median family income consistently increased in all of the regions from 1960 to 1980. Percent poverty families, on the other hand, had a relatively small increase only in three

regions. The largest decrease in percent poverty families was 4.5 percent that took place in region two.

Urbanization and Education

Table 6 shows the data on urbanization and education for each of the regions in South Dakota.

TABLE 6

SOUTH DAKOTA REGIONAL URBANIZATION AND EDUCATION DATA FOR 1960, 1970, AND 1980

	Regions / Year	1	2	3	4	5	6
Urban-zation	1960	20.4	26.8	14.1	18.3	13.4	28.1
	1970	22.8	30.2	15.4	19.4	10.4	35.2
	1980	23.9	32.5	11.8	19.6	10.6	31.6
Education	1960	9.8	10.1	9.3	9.7	9.8	10.4
	1970*	11.4	11.9	10.5	10.8	11.2	11.7
	1970**	56.9	59.0	50.0	53.3	54.1	58.1
	1980	63.4	68.6	60.0	58.7	62.7	65.8

* Median years of school completed by those 25 years old and over.
** Percent of population 25 years old and over who completed high school.

As can be seen from table 6, regions one, two, and four became continuously more urban from 1960 to 1980, whereas region five experienced a continuous overall decrease. Regions three and six witnessed an increase from 1960 to 1970, but then had a decrease from 1970 to 1980.

With reference to education, as mentioned earlier in the section on education on the state level, it is reported differently in the three decade period (median years school completed and percent high school graduates), therefore, 1970 data, which was reported in both forms, was used as a bridge to demonstrate education patterns that have taken place during this time. As can be seen from table 6, all regions have experienced continuous increase from 1960 to 1980.

Agricultural Chemical Use

Data on regional use of fertilizers, pesticides, and herbicides are presented in table 7.

TABLE 7

SOUTH DAKOTA REGIONAL AGRICULTURAL CHEMICAL USE* DATA FOR 1960, 1970, AND 1980*

	Regions / Year	1	2	3	4	5	6
Fertilizer	1960	7.2	6.4	1.8	2.8	.2	.2
	1970	21.4	26.5	10.8	13.5	2.6	1.1
	1980	34.9	40.3	21.1	18.1	4.9	1.5
Pesticide	1960	0	0	0	0	0	0
	1970	2.8	8.5	2.2	2.7	.4	.2
	1980	9.1	17.2	7.2	4.4	1.9	.6
Herbicide	1960	0	0	0	0	0	0
	1970	21.9	21.8	9.7	9.7	3.6	1.3
	1980	29.7	36.8	16.7	19.5	7.7	2.3

* Percent acres farmland treated.
** 1978 Agricultural Chemical data.

It is demonstrated in table 7 that all regions had increased use of all three chemicals. Region three experienced a tenfold increase in fertilizer use from 1960 to 1980, and regions two, four, and five, each had close to a sixfold increase during this period.

The increases in pesticide use, in percentages, were relatively modest. That is, these increases were generally of a magnitude of two or three times.

With reference to herbicides, regions four, two, and one, respectively, had the largest increases from 1970 to 1980.

Dependent Variable

Cancer Death Rates

Data on regional cancer death rates are given in table 8.

TABLE 8

SOUTH DAKOTA REGIONAL CANCER DEATH RATES* FOR 1960, 1970, AND 1980

Regions / Year	1	2	3	4	5	6
1960	1.57	3.33	1.21	1.71	5.3	1.38
1970	1.75	3.82	1.45	2.00	6.5	1.52
1980	1.85	4.57	1.57	2.08	6.9	1.96

* Deaths per 1,000.

Data in table 8 indicate a definite increase in cancer mortality for all the regions from 1960 to 1980. Region six had the largest increase (41 percent), followed by regions two (37 percent) and five (28 percent).

Regional cancer death rates, broken down by age and sex are presented in tables 9, 10, and 11 (following pages).

As can be observed from tables 9, 10, and 11, even though there are some anomalies; where death rates had a decrease, cancer deaths for both sexes has consistently increased with increases in age in all regions, and that all regions experienced a sharp increase in the age group 75 and over. One point to mention is that region four appears to have witnessed sharp increases in its male cancer mortality in age groups 55-59 and beyond in all three decades.

Cancer-specific death rates for each region for the years of 1960, 1970, and 1980 are presented in tables 12, 13, and 14.

TABLE 9

SOUTH DAKOTA REGIONAL AGE AND SEX-SPECIFIC CANCER MORTALITY RATES FOR 1960

Regions / Age Groups	1		2		3		4		5		6	
	M	F	M	F	M	F	M	F	M	F	M	F
0 - 49	.1	.3	.3	.3	.2	.3	.3	.2	.2	.3	.2	.2
50 - 54	1.4	3.3	1.2	3.5	2.1	3.6	2.0	1.9	.5	1.0	2.1	1.8
55 - 59	1.5	3.6	2.9	2.9	3.1	2.3	1.3	2.3	1.0	1.8	3.9	3.3
60 - 64	4.4	4.2	6.2	3.9	4.9	4.6	3.0	3.8	1.9	2.2	3.0	4.0
65 - 69	6.5	6.1	6.3	2.9	8.3	3.9	6.9	4.9	5.8	3.9	7.5	4.5
70 - 74	8.7	4.3	6.5	6.4	6.4	4.7	14.3	5.0	5.6	4.8	8.0	8.3
75 - +	15.8	14.5	18.2	10.2	15.6	8.3	13.0	10.4	15.9	10.8	14.9	7.6

TABLE 10

SOUTH DAKOTA REGIONAL AGE AND SEX-SPECIFIC CANCER MORTALITY RATES FOR 1970

Regions / Age Groups	1		2		3		4		5		6	
	M	F	M	F	M	F	M	F	M	F	M	F
0 - 49	.1	.3	.2	.4	.4	.3	.6	.3	.1	.2	.1	.1
50 - 54	2.2	.8	.8	1.8	1.8	1.8	2.1	3.2	.9	1.6	1.3	3.2
55 - 59	3.1	1.9	3.0	3.1	2.7	3.7	4.8	6.7	1.6	1.3	4.9	3.2
60 - 64	5.1	3.2	3.5	6.1	7.7	2.3	4.9	6.2	2.9	1.5	5.2	1.6
65 - 69	4.9	4.3	8.1	3.6	4.9	2.1	22.1	10.4	3.3	1.3	4.7	.9
70 - 74	8.5	4.1	13.6	4.6	6.9	3.4	21.6	8.3	6.2	1.5	14.4	3.6
75 - +	17.1	8.5	12.2	12.2	11.8	7.2	27.1	15.0	10.5	5.3	13.8	8.6

TABLE 11

SOUTH DAKOTA REGIONAL AGE AND SEX-SPECIFIC CANCER MORTALITY RATES FOR 1980

Regions / Age Groups	1		2		3		4		5		6	
	M	F	M	F	M	F	M	F	M	F	M	F
0 - 49	.4	.2	1.0	.2	.2	.3	.3	.3	.1	.1	.2	.1
50 - 54	1.3	2.5	.5	3.1	1.7	2.1	3.8	3.1	.3	1.3	3.0	2.7
55 - 59	1.6	.8	3.0	2.3	2.9	4.0	2.8	3.2	2.9	2.4	2.1	2.6
60 - 64	4.5	4.4	4.2	4.7	1.3	4.4	10.1	5.9	4.8	1.8	4.4	3.1
65 - 69	4.4	5.2	6.8	5.3	8.2	5.9	13.8	9.2	5.0	4.3	6.3	5.8
70 - 74	7.9	3.3	14.4	6.2	13.1	7.3	22.7	5.7	7.3	4.5	8.9	8.6
75 - +	16.5	9.6	15.7	12.1	14.1	9.8	23.7	17.0	8.7	4.7	15.8	9.9

TABLE 12

SOUTH DAKOTA REGIONAL CAUSE-SPECIFIC CANCER MORTALITY RATES FOR 1960

Regions Cancer Category	1	2	3	4	5	6
140 - 149	.03	.02	.03	.02	.00	.01
150 - 159	.66	.49	.58	.42	.44	.44
160 - 165	.18	.23	.13	.23	.14	.17
174	.05	.05	.04	.02	.03	.02
175 - 187	.33	.21	.40	.25	.19	.21
188 - 189	0	0	0	0	0	0
170 - 173/ 190 - 199	.30	.36	.39	.36	.34	.24
204 - 207	.11	.10	.10	.08	.07	.06
200 - 203/ 208 - 209	.07	.03	.08	.06	.10	.11

TABLE 13

SOUTH DAKOTA REGIONAL CAUSE-SPECIFIC CANCER MORTALITY RATES FOR 1970

Regions Cancer Category	1	2	3	4	5	6
140 - 149	.02	.07	.01	.04	.02	.03
150 - 159	.67	.48	.57	.89	.24	.35
160 - 165	.27	.30	.40	.51	.12	.26
174	.14	.17	.08	.21	.10	.08
175 - 185	.29	.37	.21	.46	.16	.19
188 - 189	.06	.10	.07	.23	.09	.08
170 - 173/ 190 - 199	.09	.12	.20	.33	.09	.10
204 - 207	.09	.06	.12	.21	.07	.08
200 - 203/ 208 - 209	.09	.06	.14	.17	.02	.04

TABLE 12

SOUTH DAKOTA REGIONAL CAUSE-SPECIFIC CANCER MORTALITY RATES* FOR 1960

Regions / Cancer Category	1	2	3	4	5	6
140 - 149	.03	.02	.03	.02	.00	.01
150 - 159	.66	.49	.58	.42	.44	.44
160 - 165	.18	.23	.13	.23	.14	.17
174	.05	.05	.04	.02	.03	.02
175 - 187	.33	.21	.40	.25	.19	.21
188 - 189	0	0	0	0	0	0
170 - 173/ 190 - 199	.30	.36	.39	.36	.34	.24
204 - 207	.11	.10	.10	.08	.07	.06
200 - 203/ 208 - 209	.07	.03	.08	.06	.10	.11

* Deaths per 1,000 population.

TABLE 13

SOUTH DAKOTA REGIONAL CAUSE-SPECIFIC CANCER MORTALITY RATES* FOR 1970

Regions / Cancer Category	1	2	3	4	5	6
140 - 149	.02	.07	.01	.04	.02	.03
150 - 159	.67	.48	.57	.89	.24	.35
160 - 165	.27	.30	.40	.51	.12	.26
174	.14	.17	.08	.21	.10	.08
175 - 185	.29	.37	.21	.46	.16	.19
188 - 189	.06	.10	.07	.23	.09	.08
170 - 173/ 190 - 199	.09	.12	.20	.33	.09	.10
204 - 207	.09	.06	.12	.21	.07	.08
200 - 203/ 208 - 209	.09	.06	.14	.17	.02	.04

* Deaths per 1,000 population.

TABLE 14

SOUTH DAKOTA REGIONAL CAUSE-SPECIFIC CANCER MORTALITY RATES* FOR 1980

Regions Cancer Category	1	2	3	4	5	6
140 - 149	.03	.01	.03	.06	.01	.03
150 - 159	.62	.52	.69	.89	.38	.38
160 - 165	.34	.35	.44	.72	.23	.31
174	.15	.19	.22	.30	.08	.11
175 - 187	.23	.23	.28	.45	.09	.14
188 - 189	.07	.12	.12	.16	.07	.04
170 - 173/ 190 - 199	.15	.18	.23	.24	.16	.16
204 - 207	.12	.05	.11	.11	.03	.05
200 - 203/ 208 - 209	.12	.10	.15	.19	.08	.09

* Deaths per 1,000 population.

Data in tables 12, 13, and 14 indicate that cancer mortality due to digestive organs in region four doubled from 1960 to 1970 and stayed at that level to 1980, whereas it decreased by almost 50 percent in region five from 1960 to 1970 and then again increased from 1970 to 1980.

Respiratory organs and female breast cancer death rates increased for all regions from 1960 to 1980.

Genital organs deaths had an overall decrease in region three. It increased sharply in region four from 1960 to 1970 and remained high to 1980.

Skin and nervous system death rates had an overall

decrease in all regions from 1960 to 1980. Finally, lymphatic tissues cancer deaths generally increased during the three decade period in all regions. In regions five and six, it decreased from 1960 to 1970, but then again increased from 1970 to 1980.

Statistical Data

This section of the paper responds to the second objective of the study. That is, significant contributors to each one of the cancer types are reported, and the study hypotheses are assessed based on the presented data. In the tables to follow, data is reported in terms of subsets with significant contribution until the explanatory power of "R squared" tapers off or that significance is lost. For each set of predictors, "R squared", the F-ratio, and the level at which F-ratio is significant, are given. As mentioned in Chapter Four, both multiple regression (Leaps and Bounds procedure) and correlation were utilized to find the variations of the dependent variable as it was associated with the independent variables and to test the hypotheses.

It should be noted that such variables as "year" and "region", were treated as "independent binary variables". Therefore, when these variables appear as significant contributors to any type of cancer death, it should be

interpreted as suggesting that there are other variables, such as water or life-style factors like smoking, or drinking, that have an influence on that type of cancer death but have not been included among the independent variables of this study. With reference to year and region, it should be pointed out that "year1" (1960) was treated as the criterion with which "year2" (1970) and "year3" (1980) were compared. The same procedure was employed for regions where "region6" was treated as the criterion.

Digestive Organs

Table 15 indicates a positive relationship between digestive organs cancer death rates and a region's educational level, herbicide use, median family income, and level of urbanization. This appears to be consistent with previous research findings that with industrialization, income, education, and urbanization also increase and that people's diet change, therefore more incidents of digestive organs cancer (Greenberg, 1983). However, urbanization alone was not significantly related to digestive organs cancer, thereby failing to support hypothesis eight which postulated a relationship between urbanization and digestive organs cancer death.

TABLE 15

SIGNIFICANT CONTRIBUTORS TO DEATHS RATES* DUE TO DIGESTIVE ORGANS CANCER

# of Predictors	R^2	F-ratio	Acceptable level**
1			4.49
Region4	.26	5.54	
Region5	.34	4.97 (-)	
2	.42		4.54
Region1		4.09	
Region4		8.55	
3	.59		4.60
Region1		8.13	
Region3		5.81	
Region4		14.87	
	.57		
Year3		13.25	
Education		13.84	
Herbicide Use		7.26	
5	.71		4.75
Year2		10.02	
Year3		19.01	
Income		21.04	
Urbanization		13.53	
Herbicide Use		9.94	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Respiratory Organs

As can be seen from table 16, median family income and herbicide use were strongly related to respiratory cancer death. Region is also very important, accounting probably for life-style or contextual factors. However, urbanization as such, is not among the significant single

variables, therefore, the data failed to support hypothesis seven which postulated a relationship between urbanization and respiratory cancer death.

TABLE 16

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO RESPIRATORY ORGANS CANCER

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Region4	.33	8.08	
Income	.27	6.18	
Herbicide Use	.26	5.74	
2	.64		4.54
Region4		14.80	
Income		12.44	
	.61		
Region4		13.09	
Herbicide Use		10.35	
	.58		
Region4		12.58	
Poverty Families		8.86	
3	.72		4.60
Region4		12.95	
Region5		7.16	
Poverty Families		15.29	
4	.83		4.67
Year3		11.55	
Region4		13.55	
Income		18.02	
Education		14.88	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Breast Cancer

Table 17 shows variables with significant association with breast cancer deaths.

TABLE 17

SIGNIFICANT CONTRIBUTORS TO DEATH RATES DUE TO BREAST CANCER

# of Predictors	R**2	F-ratio	Acceptable Level
1			4.49
Herbicide Use	.52	17.53	
Income	.43	12.19	
Pesticide Use	.39	10.15	
Poverty Families	.34	8.27	
Year3	.32	7.42	
Education	.30	(.55296 Pearson R)*	
2	.66		4.54
Region4		6.24	
Herbicide Use		23.56	
	.58		
Region4		5.46	
Income		16.23	
3	.76		4.60
Region4		8.69	
Poverty Families		6.12	
Herbicide Use		16.70	
	.74		
Region4		9.55	
Poverty Families		9.84	
Pesticide Use		14.01	
4	.78		4.67
Year2		5.29	
Year3		7.11	
Region4		8.41	
Herbicide Use		5.31	
5	.82		4.75
Year2		22.67	
Year3		19.55	
Region1		4.88	
Income		11.71	
Poverty Families		17.31	

* Model five of Leaps and Bounds procedure was used in this study, therefore only the first five significant contributors were identified. Education was not among them, but it was shown to be significant when Pearson correlation coefficient was calculated.

As can be observed from table 17, herbicide and pesticide use,, and median family income are among the single variables with highest amount of explanation for deaths due to breast cancer. Other important factors include percent of poverty families, region and year. The data in table 17 provide support for hypotheses four and five which suggested a correlation between education, and income and breast cancer death. However, it is important to note that the high correlation between breast cancer and agricultural chemical use was not encountered in the literature.

Genital Organs

The data in table 18 indicate that region is the most important factor counting for the change in the dependent variable. However, median family income and herbicide use were also, to some extent, related to genital organs cancer deaths. The data failed to provide support for hypothesis three which postulated a correlation between a region's educational level and its death due to genital organs cancer. Also, since percent of poverty families was not among the single factors which significantly contributed to the variation in this kind of cancer death, hypothesis six which stated that a region's level of poverty is related to female cervix cancer death rates, was not supported.

TABLE 18

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO GENITAL ORGANS CANCER

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Region4	.35	7.09	
Region5	.25	5.34 (-)	
3	.52		4.60
Region4		8.57	
Income		4.87	
Herbicide Use		5.55	
5	.64		4.75
Year2		7.35	
Year3		5.58	
Region3		6.00	
Region4		11.68	
Poverty Families		7.55	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Urinary Organs

With reference to urinary organs cancer deaths, table 19 indicates that both economics (median family income and percent of poverty families) and agricultural chemicals use (herbicides and pesticides), were very important.

TABLE 19

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO URINARY ORGANS CANCER

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Poverty Families	.46	13.86	
Herbicide Use	.30	6.73	
Income	.24	5.17	
Pesticide Use	.23	4.75	
2	.68		4.54
Region4		10.28	
Poverty Families		22.66	
	.62		
Poverty Families		18.81	
Urbanization		6.65	
3	.79		4.60
Region4		16.32	
Poverty Families		22.00	
Pesticide Use		7.53	
	.78		
Year2		30.27	
Year3		25.66	
Region4		12.99	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Connective Tissues and Nervous System

Data in table 20 shows that, in terms of the independent variables considered in this study, median family income and percent of poverty families are strongly related to death due to connective tissue and nervous system cancer. It is important to note the negative relationship between economic variables and

deaths due to this type of cancer.

TABLE 20

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO CONNECTIVE TISSUE AND NERVOUS SYSTEM CANCER

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Poverty Families	.54	18.73 (-)	
Year2	.25	5.32	
Income	.24	5.08 (-)	
2	.68		4.54
Region4		6.37	
Poverty Families		24.36	
	.64		
Year2		22.89	
Education		17.03	
3	.83		4.60
Region3		12.07	
Region4		15.61	
Poverty Families		46.85	
4	.87		4.67
Region2		15.58	
Region5		9.99	
Income		85.64	
Poverty Families		61.35	
5	.92		4.75
Region2		25.64	
Region3		16.77	
Income		130.71	
Urbanization		14.54	
Fertilizer Use		95.97	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Leukemia

As can be seen from table 21, none of the independent variables of the study explained the variance in leukemia death.

TABLE 21

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO LEUKEMIA

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Region4	.25	5.29	
4	.68		4.67
Region1		7.27	
Region3		12.44	
Region4		12.93	
Urbanization		6.92	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Lymphatic Tissues

As can be observed from the data in table 22, there is a negative association between fertilizer use and lymphatic tissues cancer deaths. As multiple factors are considered, then other agricultural chemicals enter the scene. However, since the contributions of pesticide and herbicide can't be distinguished from that of region, and since neither herbicide nor pesticide had a significant Pearson correlation coefficient with this type of cancer death, hypotheses one and two are rejected, since they

postulated a significant relationship between pesticide and herbicide use and lymphatic tissues cancer death rates.

TABLE 22

SIGNIFICANT CONTRIBUTORS TO DEATH RATES* DUE TO LYMPHATIC TISSUES CANCER

# of Predictors	R^2	F-ratio	Acceptable Level**
1			4.49
Poverty Families	.25	5.24 (-)	
2	.41		4.54
Year3		7.32	
Education		6.07	
	.39		
Region2		5.90	
Herbicide Use		7.39	
	.38		
Region2		7.37	
Pesticide Use		7.16	
3	.54		4.60
Region3		5.37	
Region4		8.78	
Income		5.71	

* Deaths per 1,000 population.
** Acceptable at the .05 significance level.

Summary

Table 23 presents Pearson correlation coefficients only for those variables that were significantly related to each type of cancer deaths. As can be seen, Region4, median family income, percent of poverty familites, and

herbicide use were related to more types of cancers than other variables. On the other hand, oral cavity and pharynx cancer were not significantly related to any of the variables, and leukemia and lymphatic cancer were related to only one variables.

TABLE 23

PEARSON CORRELATION COEFFICIENTS FOR INDEPENDENT VARIABLES AND CANCER TYPES

Cancer Types / Variables	Oral Cavity and Pharynx	Digestive Organs	Respiratory Organs	Breast	Genitory Organs	Urinary Organs	Skin/ Connective Tissues/ Nervous System	Leukemia	Lymphatic Tissues
Year2	-	-	-	-	-	-	-0.49966	-	-
Year3	-	-	0.49142	0.56294	-	-	-	-	-
Region1	-	-	-	-	-	-	-	-	-
Region2	-	-	-	-	-	-	-	-	-
Region3	-	-	-	-	-	-	-	-	-
Region4	-	0.50729	0.57937	-	0.55408	-	-	0.49853	-
Region5	-	-0.48694	-	-	-0.50038	-	-	-	-
Income (1)	-	-	0.52785	0.65760*	-	0.49421	-0.49105	-	-
Poverty (2)	-	-	-	0.58371	-	0.68134*	-0.73441*	-	-
Education (3)	-	-	-	0.55296	-	-	-	-	-
Urbanization (4)	-	-	-	-	-	-	-	-	-
Fertilizer (5)	-	-	-	-	-	-	-	-	-0.49676
Pesticide (6)	-	-	-	0.62297*	-	-	-	-	-
Herbicide (7)	-	-	0.51376	0.72305*	-	0.54423	-	-	-

* Significant at .01 level.

1. Median Family Income.
2. Percent Poverty Family.
3. Median Education Level.
4. Percent Urban Population.
5. Percent Land Treated with Fertilizer.
6. Percent Land Treated with Pesticides.
7. Percent Land Treated with Herbicides.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

Introduction

This chapter attempts to provide explanations for research findings in terms of the theoretical orientation of the study and the literature. Then the limitations of the study are stated, and suggestions for further research are given.

Explanations of Findings

The theoretical orientation has postulated that as the United States industrialized, long term changes in other parts of the society also took place. Among those changes were increases in the standard of living, education, and changes in people's diet, which in turn led to changes in certain cancer mortality rates. Findings are discussed in the following categories: findings of this study that were consistent with previous research; findings that were inconsistent with the literature; and then, unique or novel findings, that is, findings that were not included in the literature, are reported.

Findings Consistent with Previous Research

Economics

Both median family income and percent poverty families were significantly related to death due to

cancers of the breast, urinary organs, and connective tissue and nervous system. With reference to breast cancer, education was also significantly associated (table 23 in Chapter Five). There is, however, an apparent anomaly; breast and urinary organs cancers were positively related to both median family income and percent poverty families. The contradiction is that; "How can these cancers be positively related to both increases and decreases in income?". For breast cancer, since "later age at menopause is associated with increased risk of breast cancer" (Devesa and Diamond, 1980:523), and since the onset of menopause is related to standard of living, it is possible that those living at or below poverty line receive federal and/or state assistance, which would effect their living standard.

With reference to urinary organs cancer, the effect could be due to dietary habits, such as alcohol, coffee, or canned food consumption. That is, since kidney is an important part in this group of cancers and it is responsible for detoxification of different materials in the body, it is possible that it is exposed to more carcinogens than other parts. One might suggest that substances, like chemicals present in processed foods, or alcohol, that cause urinary organs cancers are relatively inexpensive, thereby easily available to both high and

low income people.

Findings Inconsistent with Previous Research

Agricultural Chemical Use

In this study, no significant positive association was found between the use of different agricultural chemicals and lymphatic tissues cancer and soft tissue sarcomas. In fact, a negative association was found between fertilizer use and lymphatic tissues cancer. The literature, on the other hand, had indicated a relatively consistent association between agricultural chemical use and some lymphatic tissues cancer. One possible reason could be the relatively small amount of poisonous chemicals used in South Dakota. For instance, according to 1978 Census of Agriculture, 12.2 percent of farmlands were treated with herbicide and only 3.3 percent were treated with pesticide. Other possible reason could be that there were few professional applicators who were exposed to these chemicals.

Urbanization

The fact that urbanization did not show a significant relationship with any of the cancer categories was an inconsistency. With reference to lung cancer, Greenberg (1983:47) asserted that, "By 1970-75, mortality [in the United States] due to lung cancer in

white males has almost doubled" [as compared to 1950-54]. He then, rather tacitly, attributed the rise in lung cancer mortality to urbanization and industrialization, which were related to high levels of cigarette smoking and alcohol drinking and exposed people to industrial fumes, etc. In South Dakota, male lung cancer deaths accounted for 1.4 percent of deaths in 1960, it rose to 2.3 percent in 1970, and by 1980, it was responsible for 2.7 percent of all deaths; almost double the figure in 1960. Yet respiratory organs cancer deaths were not shown to be significantly related to urbanization. It could be that by using planning districts as the unit of analysis, the urban factor of "urban" counties was reduced so much so as to lose its effect. Also to be considered is that the official definition of urban is a population of 2,500 and more. Most states have a more intensive pattern of urbanization or even metropolitization than South Dakota which is still significantly rural in characteristics.

Oral Cavity, Pharynx and Skin

There was some evidence in the literature that some oral cavity cancers, (such as head, neck, and lip, for instance) and skin cancer were more prevalent among farmers because of their prolonged exposure to sun (Burmeister et al., 1981). However, for South Dakota, no significant association was found between oral cavity

cancers and any of the study variables and skin cancer (as part of connective tissues and nervous system cancers) had a negative association.

Novel Findings

In this study, the positive association between herbicide use and cancers of the respiratory organs, breast, and urinary organs were not among the findings of previous research. In addition, pesticide use was found to be associated with breast cancer. Also, a negative association was found between economic factors (median family income and percent poverty families) and the cancer group of the skin, connective tissue and nervous system. Here too, the literature had not suggested such a relationship. In fact, there is "significant association between breast cancer and the development of meningioma [cancer of the membrane enclosing the brain]" (Griffiths et al., 1984:208). That is, high incidents of breast cancer should have led to high incidents of nervous system organs cancer.

Limitations of the Study

Limitations of this study arise from the nature of the data and the way it was originally collected. That is, the criteria on which the data were collected changed from some years to the next. As mentioned about

education, the criterion changed from "median years of school completed" in 1970 to "percent high school graduates" in 1980. Or that, tonnage of fertilizer use was collected for some years, but tonnage of other chemicals was not collected.

Another difficulty arose from the fact that the number of cancer deaths were very small if used at the county level, especially when broken by sex or race, therefore, counties were combined into regions (planning districts). This becomes more important when considering the fact that heterogeneous counties went into the making of a planning district. That is, for instance, planning district two consisted , among others, of Minnehaha county which was 78.9 percent urban in 1970 and McCook and Turner counties which were zero percent urban. This would reduce the generalizability of the results since the level of urbanization of a planning district may be different from that of the component counties. Or that each planning district consisted of different number of counties and hence, were of different sizes. This would influence the population's exposure to agricultural chemicals, since the more dense a planning district, the more the number of people who could potentially be exposed to agricultural chemicals.

Furthermore, the data could not be analyzed in

several ways simultaneously. That is, the data could not be sex, age, race, and cause-specific at the same time, because of the small incidence rates, therefore, cancer mortality rates were controlled for each one these variables one or two at a time. This would reduce the amount of control that is needed to isolate a "cause" of a certain cancer.

Some cancers are "caused" by contextual variables, such as amount of radiation in the water or in the atmosphere, exclusion of which blurs the association of certain cancers to other variables.

Finally, most cancer deaths are ultimately related to diet. That is, even income and educational differences are usually reflected in dietary habits. However, diet as such was not among the variables of this study, thereby making the association of many cancers to a specific "cause" difficult or impossible.

Recommendations

Several of the findings of this study were either novel or inconsistent with previous research findings, thus making important the continued research in this area. Among these findings, the positive association between herbicide and pesticide use and deaths due to breast cancer, primarily among women is particularly of interest for further research. For example, could it be

that South Dakota farmers rely more on the labor of their wives instead of the traditional hired labor, thereby exposing the women more to these chemicals? Or, might the residual spill off of these chemicals be disproportionately affecting women? Another curious finding was the negative association between lymphatic tissues cancer death and fertilizer use. This suggests the need for further research.

The unidirectional (whether positive or negative) association of breast, urinary organs, and connective tissue and nervous system organs cancers with both (and apparently opposite) indicators of economic status is of importance. In this respect, it would be interesting if one would divide the counties on the bases of county income, urbanization, and education and observe the differences, or omit counties with very small cancer deaths and only compare those with sufficient numbers. It is also recommended that micro level variables be included in the study of cancer since many cancers are related to living standards and dietary factors and therefore should be studied at the individual (micro) level.

Theoretical Implications

Modernization theory was employed as the theoretical framework in this study. While some of the findings

provided support for the fundamentals of this theory, other aspects of the theory were not, apparently, supported.

The increase in death due to cancers of the respiratory organs, digestive organs, female breast, and urinary organs, provided general support to the idea that as societies modernize, their living standards also increase, making them more resistant to infectious diseases. But their diet also changes. People are exposed to more chemicals, either directly in their place of work and environment, or indirectly through chemicals used in foods.

However, the theory also postulates that as societies modernize, they become more urbanized, which results in concentration of risk factors in the cities. Factors such as high rates of smoking and drinking, exposure to environmental fumes, and environmental degradation, may increase the rate of degenerative illnesses. In this study no significant relationship was found between urbanization as such and high rates of cancer mortality. This, however, could be due to the fact that different counties with extremely different levels of urbanization were combined together to construct a planning district, thereby lowering the possible effects of urbanization by itself. If more urbanized counties

could be compared with less urbanized ones in a comparison fashion, then the influence of urbanization could be assessed more precisely. Another consideration is that dietary habits were not considered in this study, and these are important factors when studying the effects of urbanization. Another route would be to compare counties with sufficient number of cancer death, to see if more urbanized counties have more death due to certain cancers. This way, modernization theory or aspects of it, could better be examined.

Summary

The findings of this study, while confirming some of the findings of previous research, presented some rather unique results and some results that were inconsistent with previous studies on cancer. The study also supported the theoretical framework employed in the study. That is, with modernization also came increases in education, urbanization, intensification of farming, more reliance on farm chemicals, and eventually a shift in the leading causes of morbidity and mortality.

REFERENCES

Agu, Vincent U.; Christensen, Bobbe L.; and Buffler, Patricia A. "Geographic Patterns of Multiple Myeloma: Racial and Industrial Correlates, State of Texas, 1969-71". Journal of the National Cancer Institute. 65,4, (October 1980):735-8.

Archer, Victor E. "Cancer Mortality in Iowa Farmers". (Letter), Journal of the National Cancer Institute, 67,4, (October 1981): 743).

Begley, Sharon; Lubenow, Gerald C.; and Miller, Mark "Silent Spring Revisited". Newsweek, (July 14, 1986): 72-3.

Bishop, C.M. and Jones, A.H. "Non-Hodgkin Lymphoma of the Scalp in Workers Exposed to Dioxins". (Letter). The Lancent, 4, (August 15, 1981): 369.

Blair, Aaron and White, Deborah W. "Death Certificate Study of Leukemia Among Farmers From Wisconsin". Journal of the National Cancer Institute, 66,6, (June 1981): 1027-30.

Blot, William J and Fraumeni, Joseph F., Jr. "Changing Patterns of Lung Cancer in the United States". American Journal of Epidemiology. 115,5, 1982: 664-73.

Bogue, Donald J. Principles of Demography. New York: John Wiley and Sons, In., 1969, ch. 15.

Brinkerhoff, David B. and White, Lynn K. Sociology. St. Paul: West Publishing Co., 1985.

Buesching, Don P. and Wollstadt, Lloyd "Cancer Mortality Among Farmers".(Letter),Journal of the National Cancer Institute, 62,3, (March 1984): 503.

Burmeister, Leon F. "Cancer Mortality in Iowa Farmers, 1971-78". Journal of the National Cancer Institute, 66,3, (March 1981): 461-4.

Burmeister, Leon F.; Van Lier, Stephanie F.; and Isacson, Peter "Leukemia and Farm Practices in Iowa". American Journal of Epidemiology, 115, 1982: 720-8.

Burmeister, Leon F.; Everrett, George D.; Van Lier, Stephanie F.; and Isason, Peter "Selected Cancer Mortality and Farm Practices in Iowa". American Journal of Epidemiology, 118,1, 1983: 72-7.

Cantor, Kenneth P. and Blair, Aaron "Farming and Mortality From Multiple Myeloma: A Case-Control Study With the Use of Death Certificates". Journal of the National Cancer Institute, 72,2, (February 1981): 251-5.

Carson, Rachel Silent Spring, Boston: Houghton Mifflin Company, 1962.

Chodack, Symon Social Development: Five Approaches with Conclusions from Comparative Analysis. New York: Oxford University Press, 1973.

Cook, Ralph R. "Dioxin, Chloracne, and Soft Tissue Sarcoma" (Letter)> The Lancent, 1, (March 14, 1981): 618.

Cowgil, Donald O. "Transition Theory as General Population Theory". Social Forces, (March 1963): 270-274.

Delzell, Elizabeth and Grufferman, Seymour "Mortality Among White and Nonwhite Farmers in North Carolina, 19876-1978", American Journal of Epidemiology, 121, 1985: 391-402.

Devesa, Susan S. and Diamond Earl L. "Association of Breast Cancer and Cervical Cancer Incidences With Income and Education Among Whites and Blacks". Journal of the National Cancer Institute, 65,3, 1980: 515-27.

Devesa, Susan S. and Diamond Earl L. "Socioeconomic and Racial Differences in Lung Cancer Incidence". American Journal of Epidemiology. 118,6, 1983: 818-31.

Doll, R. and Peto, R. "Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the U.S.".Journal of the National Cancer Institute. 66,6, 1981: 1194-1303.

Eitzen, Stanley D. Social Problems. 2ed. Boston: Allyn and Bacon, Inc., 1983, ch. 10.

Fox, Cecil H. "The Inevitability of Cancer". Science. 218, (Oct. 8th. 1982): 108.

Fox, Michael W. Agricide: The Hidden Crisis that Affects Us all. New York: Schocken Books, 1986.

Fraumeni, J.F. "Cancer of the Pancreas and Biliary Tract: Epidemiological Considerations". Cancer Research, 35,11, 1975: 3437-46.

Goode, Erica T.. and Rosenbaum, Ernest H. "Nutrition and Cancer Prevention". in Can You Prevent Cancer?: Realistic Guidelines for Developing Cancer Preventive Life-Habits. pp.74-155. Edited by Ernest H. Rosenbaum. St. Louis: C.V.Mosby Co. 1983.

Greenberg, Michael R. Urbanization and Cancer Mortality: The United States Experience, 1950-75 New York: Oxford University Press, Inc., 1983.

_____. "Changing ancer Mortality Patterns in the Rural United States". Rural Sociology, 49,1, 1984: 143-53.

Griffiths, Margaret J.; Murray, Kathleen H.; and Russo, Phyllis C. Oncology Nursing: Pathophysiology, Assessment, and Intervention. New York: Macmillan Publishing Co., 1884.

Heidelberger, Charles "Chemical Carcinogenesis". Cancer. 40,1, 1977: 430-3.

Helmrich, Susan P.; Shapiro, Samuel; Rosenberg, Lynn; Kaufman, David W.; Stolley, Paul D.; Rosensheim, Neil B.; Knapp, Robert C.; Leavitt, Thomas; Schottenfeld, David; Oengle, Ralph L.; and Levy Micha. "Risk Factors for Breast Cancer". American Journal of Epidemiology, 117,1, 1983: 35-45.

Hoar, Shelia K.; Blair, Aaron; Holmes, Frederick F.; Boysen, Cathy D.; Robel, Robert J.; Hoover, Robert; and Fraumeni, Joseph F., Jr. "Agricultural Herbicide Use and Risk of Lymphoma and Soft-Tissue Sarcoma". Journal of the American Medical Association, 256,9, 1986: 1141-7.

Honchar, P.A. and Halperin, W.E."2,4,5-T,Trichlorophenol and Soft Tissue Sarcoma". (Letter). The Lancent, 1, (January 31, 1981): 268-9.

Johnson, F.E.; Kugler, M.A.; and Brown, S.M. " Soft Tissue Sarcomas and Chlorinated Phenols".(Letter). The Lancent, 2, (July 4, 1981): 40.

Kammeyer, Kenneth C.W. An Introduction to Population, San Francisco: Chandler Publishing Co. 1971.

Kent, Saul "What is the Relationship of Cancer to Aging?" Geriatrics. 32,11, 1977: 113+

Kerlinger, Fred N. Foundations of Behavioral Research. 2nd ed. New York: Holt, Rinehart and Winston, Inc., 1973, ch. 22.

Kitagawa, Evelyn M. and Hauser, Phillip M. Differential Mortality in the United States: A Study in Socioeconomic Epidemiology, Massachussetts: Harvard University Press, 1973.

Lauer, Robert H. Perspectives on Social Change. Boston: Allyn and Bacon, Inc., 1973.

Lilienfeld, Abraham M.; Levin, Morton L.; and Kessler, Irving I. Cancer in the United States. Massachussetts: Harvard University Press, 1972.

Madigan, Francis C. "Are Sex Mortality Differences Biologically Caused?". Milbank Memorial Fund Quarterly.35,2, 1956: 202-23.

Marx, Karl "Preface to a Contribution to the Critique of Political Economy". In Marx, Karl and Engels, Frederick Selected Works. Vol. 1, Moscow: Progress Publishers, 1977: 502-16.

McKeown, Thomas and Record, R.G. "Reasons for the Decline of Mortality in England and Wales during the Nineteenth Century". Population Studies, 16,3, (November 1962): 94-122.

McKeown, Thomas; Record, R.G.; and Turner, R.D. "An Interpretation of the Decline of Mortality in England and Wales during the Twentieth Century". Population Studies, 29,3, (November 1975): 391-422.

Miller, Michael K.; Voth, Donald E.; and Danforth, Diana M. "The Medical Care System and Community Malady: Rural, Urban, and Suburban Variations in Impact". Rural Sociology. 47,4, 1982: 634-54,

Moses, Marion and Selikoff, Irving J. "Soft Tissue Sarcomas, Phenoxy Herbicides, and Chlorinated Phenols". (Letter). The Lancent, 1, (June 20, 1981): 1370.

Nam, Charles B. and Philliber, Susan G. Population: A Basic Orientation. 2nd ed. New Jersey: Printice-Hall, In., 1984.

New Scientist. "Cancer Threat to California's Water Supply",95,1317, (August 1982): 351.

Olsson, H. and Brandt, L. "Non-Hodgkin's Lymphoma of the Skin and Occupational Exposure to Herbicides". (Letter). The Lancent, (September 12, 1981): 579.

Omran, Abdel R. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change". The Milbank Fund Quarterly. 49,1, 1971: 509-38.

_____. "Epidemiologic Transition". International Encyclopedia of Population. 1: 172-83, New York: The Free Press, 1982.

_____. "Epidemiologic Transition in the U.S.". Population Reference Bulletin. 32,2, 1980.

Pearce, Neil E.; Smith, Allan H.; and Fisher, David O. "Malignant Lymphoma and Multiple Myeloma Linked with Agricultural Occupations in a New Zealand Cancer Registry-Based Study". American Journal of Epidemiology. 121,2, 1985: 225-37.

Petrikis, Nicholas L. "Cancer Epidemiology". in Can You Prevent Cancer?: Realistic Guidelines for Developing Cancer Preventive Life-Habits. pp. 17-24. Edited by Ernest H. Rosenbaum. St. Louis: C.V.Mosby Co., 1983.

Polakoff, Phillip and Rosenbaum, Ernest H. "Environmental and Occupational Risks". in Can You Prevent Cancer?: Realistic Guidelines for Developing Cancer Preventive Life-Habits. pp. 199-213. Edited by Ernest H. Rosenbaum. St. Louis: C.V.Mosby Co., 1983.

Polissar, Lincoln "The Effect of Migration on Comparison of Disease Rates in Geographic Studies in the United States", American Journal of Epidemiology, 111, 2 (1980): 175-182.

Population Reference Bureau. "U.S. Population: Where We Are; Where We Are Going". Population Reference Bulletin. 37,2. 1982.

Retherford, Robert D. The Changing Sex Differential in Mortality. Connecticut: Greenwood Press, 1975.

Riley, Marvin P. "South Dakota Population and Farm Facts: Ranking of Counties on Population Facts 1954-1959" SDSU,Department of Rural Sociology. Circular, 151 (January 1962).

Riley, Marvin P. and Butler, Eugene T. "South Dakota Population, Housing and Farm Census Facts: Ranking of counties on Population and Housing (1960-1970) and Farms (1964-1969)" SDSU, Department of Rural Sociology. Population Series, 4, Bulletin 611, (May 1973).

Riley, Marvin P.; Satterlee, James L.; and Goreham, Gary "South Dakota Population, Housing, and Farm Facts: Ranking of Counties on Population and Housing (1970-1980) and Farms (1978)" SDSU, Department of Sociology. Update Series C229, No. 10, (November 1983).

Riley, Marvin P.; Satterlee, James L.; and Crotchett, Deborah "South Dakota Population: Age and Sex Structure 1970-1980" SDSU, Department of Rural Sociology. Update Series C229, No. 9 (March 1984).

Ritzer, George Contemporary Sociological Theory. New York: Alfred A. Knopf, Inc., 1983.

Robertson, Ian Sociology. 3rd ed. New York: Worth Publishers, Inc., 1987.

Rosenbaum, Ernest H. Can You Prevent Cancer?: Realistic Guidelines for Developing Cancer Preventive Life-Habits. St. Louis: C.V.Mosby Co., 1983.

Roth, Jay S. All About Cancer. Philadelphia: George F. Stickley Co., 1985.

SAS Institute Inc. "Changes and Enhancements in the Version 5: SUGI Supplemental Library." SAS Technical Report S-131 (July 3, 1985): 5-14.

Schatzkin, Arthur; Palmer, Julie R.; Rosenberg, Lynn; Hemrich, Susan P.; Miller, Donald R.; Kaufman, David W.; Lesko, Samuel M.; and Shapiro, Samuel "Risk Factors for Breast Cacner in Black Women", Journal of the National Cancer Institute, 78,2, 1987:213-7.

Schluter, Gerald and Edmondson, William "How To Tell How Important Agriculture Is To Your State", Rural Development Perspective. (June 1986): 32-4

Smelser, Neil J. Essays in Sociological Explanation. Englewood Cliffs: Prentice-Hall, Inc., 1968: 126.

South Dakota Department of Health. South Dakota State Board of Health. The Fourteenth Biennial Report. Pierre: South Dakota: 1940.

_____. South Dakota Vital Statistics. Annual Statistical Report. Pierre: South Dakota, 1919, 1932, 1951-1980, 1982.

Thomlinson, Ralph Population Dynamics: Causes and Consequences of World Demographic Change. New York: Random House, Inc., 1965.

Turner, Jonathan H. The Structure of Sociological Theory. 3rd ed. Homewood: The Dorsey Press, 1982.

United States Department of Commerce, Census of Agriculture, Bureau of the Census, State and County Data, South Dakota, 1959, 1969, 1978

Vago, Steven Social Change. New York: Holt, Rinehart, and Winston, 1980, ch. 5.

Walters, A.H. "Nitrate and Cancer: A Broader View". The Ecologist, 14,1, 1984: 32-7.

Weeks, John R. Population: An Introduction to Concepts and Issues. 3rd ed. Belmont: Wadsworth Publishing Co., 1986.

Young, John L., Jr.; Ries, Lynn Gloeckler; and Pollack, Earl S. "Cancer Patient Survival Among Ethnic Groups in the United States". Journal of the National Cancer Institute, 37,2 (August 1984): 341-52.